CENTRAL VALLEY PROJECT IMPROVEMENT ACT
PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

DRAFT TECHNICAL APPENDIX

Evaluation of Preliminary Alternatives

September 1997

TABLE OF CONTENTS

Items **Page**

Items **Page**

Items **Page**

Items **Page**

Items **Page**

Items **Page**

LIST OF TABLES

Items **Page**

Items **Page**

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

AFRP	Anadromous Fish Restoration Program
cfs	cubic feet per second
COA	Coordinated Operations Agreement
COE	U.S. Army Corps of Engineers
CVGSM	Central Valley Ground-Surface Water Model
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
DCC	Delta Cross Channel
DFG	California Department of Fish and Game
DBP	disinfection byproducts
DWR	California Department of Water Resources
FIRE	finance, insurance, and real estate
GRCD	Grassland Resource Conservation District
GWh	gigawatt-hours
M&I	municipal and industrial
MW	megawatt
NMFS	National Marine Fisheries Service
NWR	National Wildlife Refuge
PEIS	Programmatic Environmental Impact Statement
PG&E	Pacific Gas and Electric Company
ppt	parts per thousand
RBDD	Red Bluff Diversion Dam
Reclamation	U.S. Bureau of Reclamation
Service	U.S. Fish and Wildlife Service
SJVDP	San Joaquin Valley Drainage Program
SWP	California State Water Project
SWRCB	California State Water Resource Control Board
Western	Western Area Power Administration
WMA	Wildlife Management Area
USDA	U.S. Department of Agriculture

CHAPTER I

INTRODUCTION

Chapter I

INTRODUCTION

The purpose of this technical appendix is to present the results of the impact assessment of preliminary alternatives considered for the Draft Programmatic Environmental Impact Statement (PEIS) for the Central Valley Project Improvement Act (CVPIA). The results of the impact assessment were compared to screening criteria to identify the final alternatives to be considered in the Draft PEIS.

Alternatives considered in the PEIS were developed through a three-phase screening process.

The first phase of the screening process identified potential options for implementation of CVPIA provisions. The CVPIA includes a variety of provisions directing or authorizing the Secretary of the Interior (Secretary) to implement administrative actions, studies, and a program of physical and operational changes to the Central Valley Project (CVP). Certain provisions of CVPIA were eliminated from further consideration in the Draft PEIS based upon a determination that the provision would not result in a federal action or potentially cause an impact on the environment without the completion of future environmental documentation. Options were developed for the remaining provisions.

The second phase of the screening process eliminated some of the remaining options for implementation of the CVPIA provisions based upon preliminary analysis. Options carried from the first phase of the screening process were reviewed based on available reports and extensive input obtained from interagency work teams and during the scoping process and scheduled public forums. These options were screened to identify feasible options and eliminate any that were clearly inappropriate. The options remaining from this screening needed to address a purpose of the CVPIA and were grouped into preliminary alternatives. If several options were available to implement a particular provision, but the level of analysis for the Draft PEIS would not be able to distinguish among them, the options were combined.

During the third phase, preliminary alternatives were analyzed to determine the final alternatives to be included in the PEIS. The preliminary alternatives were analyzed with the analytical tools, and the results were compared with biological, hydrological, and economic screening criteria. An initial impact assessment of environmental consequences was completed and the results were compared to the screening criteria to allow refinement of the alternatives. The results of the initial impact assessment are presented in Chapter III of this technical appendix, and the results of the screening process are presented in Chapter IV.

SCREENING CRITERIA FOR PRELIMINARY ALTERNATIVES

The screening criteria for the third phase were identified by the AFRP process as criteria to develop reasonable actions for target flows. These four criteria also are appropriate for screening alternatives with respect to both fishery and water management actions.

- **Biological Priorities** - Flows must be managed in a way to support biological priorities, including species and lifestages. Use of water for the lifestages of species of concern would be prioritized. Preliminary biological priorities developed through the AFRP process were used to prioritize use of acquired water and the (b)(2) Water.

- **Water Availability** - Flows must be physically available assuming existing facilities.

- **Cost of Water** - The costs of acquiring water are dependent upon the watershed and the use of the water by users. The marginal cost of water analysis was used in the initial analysis for determining the range of average annual quantities that could be acquired. It is assumed that the cost of acquired water would reflect actions taken by users to reduce water demands. Cost curves were developed for each river to evaluate cost per acre-foot acquired. The break-points in the cost curves were compared with biological priorities. For the purposes of the third phase of the screening process, water costs in excess of $150/acre-foot were considered to be high and possibly unreasonable on most rivers.

- **Fund Availability** - Most of the actions considered in the PEIS are funded through the Restoration Fund, nonreimbursable Federal funds, and State of California funds. The Restoration Fund collections are limited to a maximum of $50 million/year, and are frequently less due to limitations on CVP water deliveries. Therefore, the initial fund limitation was considered to be limited by the $50 million/year Restoration Fund limitation. However, other federal, state, and local programs are currently evaluating projects that are similar to programs included in the PEIS alternatives. As a result of other funding sources, the total funds available through all sources may be greater than $50 million/year. For this analysis, a total funding capability of about $100 - 120 million/year was considered to be "available" to fund the portions of the project to be funded by the "Restoration Fund". It was assumed that funds for all actions would be available.

CHAPTER II

PRELIMINARY ALTERNATIVES CONSIDERED

Chapter II

PRELIMINARY ALTERNATIVES CONSIDERED

INTRODUCTION

As part of the development of alternatives for inclusion in the Draft PEIS, preliminary alternatives were first developed and subjected to screening criteria to allow for further refinement of the final alternatives. The purpose of this chapter is to describe the preliminary alternatives considered and the results of the screening process.

DEVELOPMENT OF PRELIMINARY ALTERNATIVES

In the third phase of the screening process, preliminary alternatives were analyzed to identify similarities and distinguishing characteristics. This phase of the screening process involved the use of analytical tools, including surface water hydrologic models, to evaluate preliminary information developed by the Anadromous Fish Restoration Program (AFRP). The AFRP actions included both non-flow habitat restoration actions (such as gravel restoration or use of fish screens) and target flow actions to use all reasonable efforts to provide for sustainable natural production of anadromous fish in the Central Valley rivers and streams on a long-term basis at levels not less than twice the average levels attained during the period of 1967 through 1991.

In December 1995, the Service prepared a Draft AFRP Restoration Plan, including specific target flows to be implemented in the Delta and on the CVP-controlled Central Valley streams (Sacramento River, Clear Creek, American River, and Stanislaus River). Target flows for non-CVP controlled rivers were not available in the Draft AFRP Restoration Plan and were developed based upon preliminary information from the AFRP process for each watershed. The Draft AFRP Restoration Plan also included non-flow actions for all Central Valley streams.

This information was used to define flow management and fishery management actions for five alternatives. All five alternatives included the same non-flow actions. The differences between the alternatives were determined by the methods to increase instream flows toward the AFRP target flows and the actions to provide additional refuge water supplies. Additional flows could be provided in three ways: 1) Re-operation of the CVP facilities under section 3406(b)(1)(B) of CVPIA, 2) use of "(b)(2) water" under section 3406(b)(2), or 3) water acquisition under section 3405(b)(3). Additional refuge water supplies, between firm Level 2 and Level 4, would be provided by the CVP and through water acquisition under section 3405(b)(3).

DESCRIPTION OF THE PRELIMINARY ALTERNATIVES

The preliminary alternatives included the No-Action Alternative and five main alternatives. The No-Action Alternative is described in the Development of the No-Action Alternative Technical Appendix. The five preliminary alternatives are described below.
The preliminary alternatives were developed to evaluate a range of actions to implement provisions of CVPIA. As described at the beginning of this section, many of the actions did not have multiple methods to implement the CVPIA provisions. Therefore, these actions were included in the same manner in all alternatives. These "common" actions are described below under Alternatives 1 through 5.

The multiple option "common" actions are the basis for differentiating between alternatives. To determine the impacts and benefits between some of the multiple option actions, an assessment of all issue areas was required, including an analysis of water facilities operations, power resources, fishery resources, vegetation and wildlife, recreation, and economics. These multiple option actions were used to define the differences between Alternatives 1, 2, 3, 4, and 5.

ALTERNATIVES 1 THROUGH 5

The following "common" actions are implemented in the same manner in all Draft PEIS alternatives.

- **Contract Renewals [Section 3404(c)]:** All CVP Service, Settlement, and Exchange Contracts would be renewed (no change from No-Action Alternative).

- **Water Measurement [Section 3405(b)]:** For all alternatives, two different types of water measurement actions would be considered. In one type, deliveries would be measured to all agricultural and municipal contractors at the point of diversion from the CVP facilities or supplies with implementation of some method to estimate deliveries to individual users. In the second type of water measurement, deliveries would be measured at the point of use for all users.

- **Water Conservation Standards [Section 3405(e)]:** In accordance with the 1982 Reclamation Reform Act (no change from No-Action Alternative). However, final water conservation plans would always include all cost-effective Best Management Practices that are economical and appropriate, including measurement devices; pricing structures; demand management staff; public information; financial incentives; and water management services.

- **(b)(1) "other" Program [Section 3406(b)(1)]:** In addition to the needs of specific fish species and migratory waterfowl, which are addressed in other portions of the CVPIA, Reclamation and the Service also would address the needs of other species that may have been adversely affected by construction and operation of the CVP. The (b)(1) "other" Program would make all reasonable efforts to mitigate for past impacts of the CVP on fish, wildlife, and habitat resources not specifically identified in other portions of the CVPIA.

- **Shasta Temperature Control Device [Section 3406 (b)(6)]:** Construct as in the No-Action Alternative with partial funding from the CVPIA Restoration Funds.

- **Coleman Fish Hatchery Modifications [Section 3406(b)(11)]:** Complete hatchery improvements in accordance with existing plans with partial funding from CVPIA Restoration Funds.

- **Clear Creek Restoration [Section 3406(b)(12)]:** Complete non-flow improvements in accordance with existing plans with partial funding from CVPIA Restoration Funds to expand the spawning and rearing areas. In addition, sediment would be periodically removed from the McCormick-Saeltzer Dam sediment trap.

- **Non-Flow Stream Restoration Actions [Section 3406(b)(13)]**: Implement all non-flow habitat restoration actions identified in the December 1995 Draft AFRP Restoration Plan and listed in Attachment F of the PEIS, including gravel restoration, riparian meander belts, and restoration of vegetation, with partial funding from CVPIA Restoration Funds.

- **Anderson-Cottonwood Irrigation District Diversion Modification [Section 3406(b)(17)]:** Complete diversion structure modifications to protect fish while delivering historical amounts of water with partial funding from CVPIA Restoration Funds. Improvements will to improve fish passage, reduce incidents of fish stranding, and avoid redd dewatering.

- **Glenn-Colusa Irrigation District Diversion Facility Modification [Section 3406(b)(20)]:** Complete diversion structure modifications at the Hamilton City Pumping Plant to protect fish while delivering historical amounts of water with partial funding from CVPIA Restoration Funds.

- **Construction of Fish Screens and Bypasses at Central Valley Stream Diversions [Section 3406(b)(21)]:** Complete fish screens and similar structures while delivering historical amounts of water with partial funding from CVPIA Restoration Funds.

- **Increased Instream Releases in Trinity River [Section 3406(b)(23)]:** The CVPIA recognizes a concurrent program that is evaluating flows in the Trinity River to improve fishery conditions. This study, which will be completed in 1997, will evaluate and analyze a range of reasonable alternatives to restore and maintain the natural production of anadromous fish populations of the Trinity River mainstem downstream of Lewiston Dam. For the purposes of the PEIS, the Service developed an instream flow release pattern for the Trinity River that may be similar to alternatives being evaluated in the concurrent Trinity River study.

ALTERNATIVE 1

The following actions were implemented in Alternative 1 in addition to the "common" actions described above.

- **Fish and Water Management Actions [Sections 3406(b)(1-3)]:** The actions included methods to meet target flows identified in the preliminary AFRP Draft Plan and Draft Working Paper. The CVPIA provided three tools to meet the AFRP target flows: 1) Reoperation in accordance with Section 3406(b)(1)(B) of the CVPIA; 2) Dedication of 800,000 acre-feet of CVP water in accordance with Section 3406(b)(2) (also known as

"(b)(2) Water"); and Water Acquisitions in accordance with Section 3406(b)(3). Although it is recognized that all three tools provided by CVPIA would be used to meet the AFRP goals, under Alternative 1 only two of the tools provided by CVPIA , Reoperation and (b)(2) Water Management, would be used to attempt to meet the AFRP target flows, as defined in Attachment G of the PEIS. Reoperation is defined as changes in CVP operations that do not impact water deliveries to CVP water users. Much of this type of reoperation had been initiated prior to the passage of CVPIA through adaptive management programs between the U.S. Bureau of Reclamation (Reclamation), the U.S. Fish and Wildlife Service (Service), and the California Department of Fish and Game (DFG). Reoperation would only affect stream flows on CVP-controlled streams identified in the CVPIA: Sacramento, American, Stanislaus, and lower San Joaquin rivers and Clear Creek. Reoperation actions range from release of additional instream flows in spring months to an increase in reservoir storage in September for higher water releases in the fall months.

The (b)(2) Water Management is defined as operation of the CVP in a manner that would allow the CVP to dedicate and manage 800,000 acre-feet/year of CVP water for fish and wildlife purposes. For the Draft PEIS, this management was implemented in a manner that would result in the reduction to CVP water service contractors of 800,000 acre-feet of deliveries. Due to water rights settlements and water rights agreements established by the State Water Resources Control Board (SWRCB), implementation of (b)(2) Water Management could not impact water rights holders, Sacramento River Water Rights Contractors, or San Joaquin River Exchange Contractors in any greater amounts than would have been allowed under the No-Action Alternative. In addition, the (b)(2) Water Management could not impact operations established by the winter-run chinook salmon biological opinion. The (b)(2) Water Management could reduce deliveries in some water year types to agricultural water service contractors as much as 100 percent of the allocation under the No-Action Alternative. However, the (b)(2) Water Management could not reduce municipal water service contract deliveries more than a maximum of 25 percent in accordance with the CVP water shortage criteria.

The (b)(2) Water Management included several components in Alternative 1. The Bay-Delta Plan Accord recognized CVPIA, and therefore, the reduction in CVP water deliveries attributed to the Bay-Delta Plan Accord was considered to be part of the 800,000 acre-feet allocation, and referred to as the "Bay-Delta Plan Component."

The remaining water allocations that could be provided on the CVP-controlled streams to meet the Draft AFRP target flows were referred to as the "Instream Component." The primary goal of (b)(2) Water Management was to provide water for AFRP salmon and steelhead target flows in the following rivers:

- Sacramento River as measured at Keswick Dam
- Clear Creek below Whiskeytown Dam
- American River as measured at Nimbus Dam
- Stanislaus River as measured at Goodwin Dam
- Lower San Joaquin River downstream of Stanislaus River confluence.

- **Refuge Water Supply Actions [Section 3406(d)(1-2)]:** Alternative 1 included a firm CVP water supply to 19 refuges at an average historic water supply levels based upon deliveries between 1978 and 1984, as described as "Level 2" in the 1989 Refuge Water Supply Study, and as described in the San Joaquin Basin Action Plan, as described under the No-Action Alternative. The refuges included both nationally owned National Wildlife Refuges (NWRs) and state-owned Wildlife Management Areas (WMAs). Many of the refuges received historical water supplies from multiple sources, such as return flows and temporary annual contracts. During recent years, water conservation programs and increased demand for water reduced the reliability of these water sources. Under Alternative 1, firm water supplies are provided to the refuges from the CVP, including conveyance losses which frequently had been provided by users that conveyed water to the refuges. In addition, Alternative 1 Level 2 refuge water supplies include water to refuges that currently are correcting conveyance capacity limitations. Therefore, Level 2 refuge water supplies under Alternative 1 are greater than under the No-Action Alternative. Alternative 1 assumes that the existing conveyance facilities and agreements would continue to be used to provide water to the refuges. Shortage criteria for the refuges would allow for shortage criteria in accordance with the Shasta Index in accordance with recent CVP operations which allows for a maximum shortage of 25 percent under specific hydrologic conditions.

- **Seasonal Field Flooding Actions (Section 3406[b(22)]):** In Alternative 1, up to 80,000 acres of land would be seasonally flooded in the Sacramento and San Joaquin valleys for the purpose of providing seasonal wetlands. The program would include a financial incentive program for the farmers through payments of up to $25 per acre of seasonally flooded fields.

- **Delta Actions (Sections 3406[b(4-5, 14-15)]):** In Alternative 1, the Delta actions would provide fish protection through improvements to fish protection facilities at Tracy and Contra Costa pumping plants.

- **Water Transfer Actions [Section 3405(a)]:** Under Alternative 1, no CVPIA water transfers of CVP water would occur.

- **Water Pricing Actions [Section 3405(d)]:** The water pricing policies under Alternative 1 would be based upon a method using "80/10/10 Tiered Water Pricing up to Full Cost" approach. Under this approach, the first 80 percent of contract volume would be priced at the applicable contract rate in accordance with current Reclamation pricing policies for the CVP. The next 10 percent of the contract volume would be priced at a value equal to the average between the contract rate and full cost rate as defined in current Reclamation pricing policies. The final 10 percent of the contract volume would be priced at full cost rate as defined in current Reclamation pricing policies. For example, if the Contract Rate was $20 per acre-foot and the Full Cost Rate was $40 per acre-foot under the No-Action Alternative; the first 80 percent of the contract amount would be priced at $20 per acre-foot, the next 10 percent would be priced at $30 per acre-foot, and the last 10 percent would be priced at $40 per acre-foot. The contract rate would be continued to be determined in accordance with the Reclamation Reform Act and current pricing policies as in the No-Action Alternative. The final price of CVP water would be determined using the current Ability-to-Pay policies, if applicable. The Ability-to-Pay policy provides relief to the users on the repayment of the capital cost of the CVP facilities. The relief could be up to 100 percent of the capital cost

repayment and is based upon local farm budgets. The Ability-to-Pay policies do not apply to CVP operation and maintenance costs or any non-CVP costs, including Federal government loans for construction of irrigation facilities.

The price for CVP water also would include collection of the Restoration Funds at a rate of $6 per acre-foot for agricultural water contractors and $12 per acre-foot for municipal water contractors. It is assumed that all contracts will be renewed to avoid additional charges specified in the CVPIA for not modifying contracts to include CVPIA provisions.

- **Red Bluff Diversion Dam Operations [Section 3406(b)(10)]:** The gates at the Red Bluff Diversion Dam allow water to move from the Sacramento River into the Tehama-Colusa Canal and Corning Canal. Downstream migrating juvenile chinook salmon and steelhead were subjected to hazards of injury and disorientation while passing through facilities, and heavy predation by squawfish below the dam. Alternative 1 assumes that the current gate operation would continue which would allow for the gates to be open mid-September to mid-May as required by the winter run chinook salmon biological opinion. It is assumed that water delivery would be the same as under the No-Action Alternative, and that adequate fish passage would be provided. This alternative would maintain the seasonal lake at Lake Red Bluff.

- **Land Retirement Actions [Section 3408(h)]:** The land retirement program is currently being developed to address a methodology to reduce drainage flows from portions of the Central Valley that contribute to water quality problems in tributaries to the Delta. For the purposes of the Draft PEIS, it was assumed that the land retirement program would be similar in nature to the program describe by the San Joaquin Valley Drainage Program (SJVDP). The SJVDP recommended drainage management actions including selective retirement of irrigated lands that are characterized by low productivity, poor drainage, and high selenium concentrations in shallow groundwater. About 45,000 acres of land discussed in preliminary documents for the Drainage Program were assumed to be retired under the No-Action Alternative, primarily through the State San Joaquin Valley Drainage Relief Act. An additional 30,000 acres of land would be retired under the Draft PEIS alternatives using mechanisms provided by CVPIA. It is assumed that the land would be located in the San Joaquin and Tulare Lake regions of the study area. This programmatic approach for the Draft PEIS provides an analysis of changing crop patterns in the area of the Central Valley characterized by drainage problems without specifically addressing the retirement of individual parcels.

ALTERNATIVE 2

Actions under Alternative 2 would include the "common" actions and be similar to those actions described under Alternative 1 except for Fish and Water Management Actions due to the addition of the use of Acquired Water in accordance with Section 3406(b)(3), and Refuge Water Supplies.

- **Fish and Water Management Actions:** Water would be acquired from willing sellers on the Stanislaus, Tuolumne, and Merced rivers in order to increase the instream flows towards the target flows identified for chinook salmon and steelhead in the AFRP Draft Plan for the

Stanislaus River and the AFRP Draft Working Paper for the Tuolumne and Merced rivers. The amount of water to be acquired would be limited by the limits of the Restoration Fund of $50 million/year, following implementation of the non-flow actions discussed in Alternative 1. In addition, the amount of water to be acquired would be limited by the willingness of water rights holders to sell their water. In Alternative 2, the acquired water would be acquired for instream and Delta purposes, and could not be used to increase Delta exports by the CVP and SWP over exports determined in Alternative 1.

- **Refuge Water Supply Actions:** Under Alternative 2, the CVP would continue to provide firm Level 2 water supplies, as discussed under Alternative 1. In addition, water would be acquired for the increment of water supply between Level 2 and Level 4 as defined in the Refuge Water Supply Study and San Joaquin Basin Action Plan. Level 4 water supply is defined as the water supply to fully develop the refuges considered in this analysis.

ALTERNATIVE 3

Actions under Alternative 3 would include the "common" actions and those actions described under Alternatives 1 and 2 except for Fish and Water Management Actions due to the increased use of Acquired Water.

- **Fish and Water Management Actions:** Under Alternative 3, the fish and water management actions would be similar to those described under Alternative 2, except that the amount of water acquired would be larger than under Alternative 2. Water would be acquired from willing sellers for instream releases on the Stanislaus, Tuolumne, and Merced rivers to meet target flows for chinook salmon and steelhead, and partial flows for sturgeon, American shad, and striped bass. Alterative 3 includes acquisition of water on the Stanislaus, Tuolumne, and Merced rivers to meet AFRP salmon and steelhead target flows, in all months, but with primary emphasis in February through June. This water acquisition would increase flows in the San Joaquin River and Delta outflows.

ALTERNATIVE 4

Actions under Alternative 4 would include the "common" actions and those actions described under Alternatives 1 through 3 except for Fish and Water Management Actions due to the increased use of Acquired Water.

- **Fish and Water Management Actions:** Under Alternative 4, the fish and water management actions would be similar to those described under Alternative 3, except that the amount of water acquired would be larger. Water would be acquired from willing sellers for instream releases on the Feather, Yuba, Mokelumne, Calaveras, lower San Joaquin, Stanislaus, Tuolumne, and Merced rivers to meet target flows for chinook salmon and steelhead, and partial flows for sturgeon, American shad, and striped bass in order to increase the instream flows towards the target flows identified for chinook salmon and steelhead in the AFRP Draft Working Paper. The water would be released to provide more stable flows in October through March and to meet spring pulse target flows in April through June.

ALTERNATIVE 5

Actions under Alternative 5 would include the "common" actions and those actions described under Alternatives 1 through 4 except for Fish and Water Management Actions due to the increased use of Acquired Water and the implementation of additional non-flow actions.

- **Fish and Water Management Actions:** Under Alternative 5, the fish and water management actions would be similar to those described under Alternative 3, except that the amount of water acquired would be larger and additional non-flow actions would be implemented. Water would be acquired from willing sellers on Central Valley streams tributary to the Delta in an attempt to meet the Draft AFRP Working Paper target flows for chinook salmon, steelhead trout, shad, sturgeon, striped bass, and other Delta species. Operations would include spring pulse flow releases for green and white sturgeon in February through May, and American shad in April through June. Major increases in Delta outflows in January through May would be provided for striped bass target flows.

All surface water diversions in the affected watersheds that would serve agriculture and projected municipal growth under the No-Action Alternative would be acquired to meet the Draft AFRP Working Paper flow requirements. In addition, all Central Valley water exports which would not be classified as necessary under Public Health and Safety requirements would be acquired under Alternative 5. Not all Draft AFRP Working Paper target flows would be achieved due to limited water supply, operating requirements under the Biological Opinion for Winter-Run Chinook Salmon, and the operational limitations of the physical and hydrologic systems.

CHAPTER III

ENVIRONMENTAL CONSEQUENCES

Chapter III

ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

This chapter presents a summary of the preliminary impact assessment for the preliminary alternatives evaluated in comparison to the No-Action Alternative. This summary is intended to provide an overview of the impacts for each issue area, and a basis for screening criteria that was presented in Chapter II. For some issue areas the preliminary impact assessment results presented in this chapter may differ from the results shown in the Draft PEIS for the alternatives selected for further analysis. This is because revisions to analysis methodologies and changes in methods of impact assessment reporting have further refined the impact results presented in the Draft PEIS. There refinements do not affect the results of the screening process described in this technical appendix. The following issue areas were evaluated and summarized.

- Fisheries Resources
- Surface Water Facilities and Supplies
- Groundwater
- CVP Power Resources
- Municipal and Industrial Land Use and Demographics
- Agricultural Economics and Land Use
- Recreation
- Recreation Economics
- Regional Economics
- Vegetation and Wildlife
- Air Quality
- Soil/Erosion Potential
- Visual Resources
- Public Health: The Delta as a Source of Drinking Water
- Public Health: Mosquitos
- Social Analysis
- Cultural Resources

FISHERY RESOURCES

Implementing the CVPIA will affect aquatic habitats throughout the Sacramento-San Joaquin River basins. The changes in habitat conditions are complex and extensive, affecting fisheries resources in reservoirs, major rivers, tributary streams, the Sacramento-San Joaquin Delta estuary, and in the Pacific Ocean.

IMPACT ASSESSMENT

The changes to fishery resources due to implementation of CVPIA were evaluated to measure the response to factors that directly affect fish abundance, production, and distribution.

Population models generally estimate population abundance under variable habitat conditions (i.e., variable flow and temperature), although existing population models generally focus on one race of one species in one river and are based on data that are incomplete. Changes in population abundance attributable to actions implemented under the CVPIA cannot be reliably determined with available data. The CVPIA clearly acknowledges current data limitations and the need for additional information and modeling to support the PEIS process. CVPIA Section 3406(b)(16) directs the Service to establish, in cooperation with independent entities and the State of California, a comprehensive assessment program to monitor fish and wildlife resources in the Central Valley to assess the biological results and effectiveness of actions implemented pursuant to CVPIA Section 3406(b) (i.e., actions identified in the alternatives included in this PEIS). In addition, CVPIA Section 3406(g) directs the Service to develop ecosystem and water system operations models that support efforts to fulfill the requirements of the CVPIA through improved scientific understanding of measures needed to restore anadromous fisheries to optimum and sustainable levels in accordance with the restored carrying capacities of Central Valley rivers, streams, and riparian habitats.

Use of existing population models in this PEIS would imply a level of knowledge not supported by available data. For the fisheries evaluation, qualitative discussion of the changes in flow, temperature, diversion delivery patterns and other attributes, rather than direct measures of fish population abundance are used. This approach was selected because the relationships between impact mechanisms and biological responses are poorly understood or adequate only under a narrow range of conditions. Biological relationships from existing models and tools are used in developing this fisheries impact analysis.

Relationships developed from the analysis of an extended database, including potential mechanisms and population information, generally focus on specific life stages and environmental mechanisms that appear to explain part of the variability in estimates of population parameters. The development of relationships that may be used for impact assessment often relies substantially on professional judgment.

The relationships between impact mechanisms and biological responses used in this PEIS assessment of impacts to fisheries provide the best available tool to estimate the change in a population parameter in response to an impact mechanism. Although the relationships are based on the best available information, a numerical estimate of a biological response, such as an actual change in population numbers, is not possible in this impact assessment because the relationships occur in complex conditions and during variable periods that cannot be accurately characterized and incorporated into simulated monthly conditions. For this impact assessment, the difference between an alternative and the No Action Alternative is an estimate that portrays direction and magnitude of a particular response.

Qualitative impact assessment was completed for the following impact mechanisms:

- flows, including discussion of how flow contributes to fish habitat, salmon survival, striped bass abundance, American shad abundance, and overflow habitat;
- water temperature, as a survival attribute;
- diversions, including discussion of how river diversions affect fry and juvenile salmon survival, Delta pathway diversion effects on fry and juvenile salmon survival, Delta diversion effects on fry and juvenile salmon and other species survival, and planktonic life stage diversion survival;
- estuarine salinity, as a salinity habitat attribute; and
- reservoir drawdown, as spawning habitat and rearing habitat attributes.

NO-ACTION ALTERNATIVE

The analysis for fish addressed impacts to chinook salmon and steelhead trout, green and white sturgeon, American shad, striped bass, and delta and estuarine species is summarized below.

Chinook Salmon and Steelhead Trout

The individual life stages for fall-run chinook salmon under the No-Action Alternative exhibit a range of survival conditions. For the spawning and rearing life stages, variable instream flows are attributable to less favorable survival conditions. During the incubation life stage (October through February), stable or increasing monthly average flows are typically present, contribute to good survival conditions during this life stage. Conversely, during the juvenile rearing life stage, the average flow present during January through May (the fry and juvenile rearing period) are often less than the flow identified for rearing conditions, contributing to poorer survival conditions for these rearing life stages.

The No-Action Alternative for late fall-run chinook salmon provides additional flows in the Sacramento River when the incubation, fry rearing, and juvenile rearing are present improving survival conditions only slightly.

Winter-run chinook salmon survival conditions in the No Action Alternative are variable for those streams with winter-run chinook salmon. Flows in the Sacramento River appear favorable for incubation and fry rearing and provide adequate survival conditions. Conversely, average flows in the Calaveras River during the winter-run juvenile rearing period (September through November) are less than the flow needs identified in the AFRP.

For the spring-run chinook salmon under the No-Action Alternative, survival conditions for the incubation, fry rearing, and juvenile rearing life stages are marginal due to typically low flow in the Sacramento River during September and October (incubation and juvenile rearing) and May and June (fry rearing).

The steelhead trout incubation, fry rearing, and juvenile rearing life stages occur during an extended period and are susceptible to instream conditions that adversely affect survival. Fry rearing typically occurs between March and August, with juvenile rearing often continuing for the entire year. Average monthly flow in the Sacramento and Feather rivers exceeds the flow needs identified in the AFRP; although average monthly flow in the American, Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced rivers (44 percent of the rearing habitat) is less than the flow need identified in the AFRP during part or all of the fry and juvenile steelhead trout rearing period.

Under the No-Action Alternative conditions, the temperature survival conditions were moderate to low, indicating that chinook salmon and steelhead trout could benefit from the cooler temperatures. These conditions could result from controlled flow augmentation/alteration in the Sacramento-San Joaquin River system.

The attributes describing the effects of diversions on juvenile fish are numerous, and do not incorporate all factors that could affect the magnitude of individual diversion impacts, including diversion location, diversion structure, fish behavior, migration timing, and predation. The effects of diversions on survival of chinook salmon and steelhead trout focused on the average timing of fry and juvenile emigration. Emigration timing varies each year depending on water temperature, fish density, food availability, water turbidity, flow volume, and genetic variability.

Winter-run chinook salmon typically have the highest river diversion survival conditions because emigration occurs during late fall and winter when diversions are relatively low and instream flows are potentially high. Fall-run chinook survival conditions are more complex because of spring emigration when the proportion of instream flow diverted may be high, and fall-run chinook salmon are found throughout the Sacramento-San Joaquin River basins. Hence, the fall-run population is exposed to more diversions than other runs of chinook salmon.

The annual Delta pathway diversion conditions for the 1922-1990 hydrologic simulation are highly variable. This is attributable to the proportion of Delta inflow diverted from Delta channels within the Delta. Pathway diversion survival conditions are high when either channel flow is high relative to the volume of diversions, or when diversions are low.

Spring-run chinook are the least affected by Delta diversions because juveniles emigrate during winter and late spring when Delta inflow is high and the proportion of Delta inflow diverted is low. Conversely, late fall-run chinook are most affected because emigration occurs during both late spring and early fall. During both of these periods, Delta diversions are proportionally high relative to inflow volume.

The primary emigration of fall-run chinook salmon occurs during spring when diversions are increasing, whereas winter-run emigration occurs during late fall and winter when diversions are decreasing. Fall-run emigration exposes juveniles to higher diversions, hence lower annual survival conditions. Delta channel diversion survival conditions for steelhead trout are generally intermediate to fall and winter-run, and is reflected by the overlap in emigration timing with both runs of chinook salmon.

The direct and indirect effects of Delta flow divisions, diversions, and temperature conditions on survival of juvenile chinook salmon during migration through the Delta are represented by the salmon survival conditions of the No-Action Alternative. Salmon survival fluctuates primarily in response to variable water temperature conditions during migration through the Delta. State Water Project (SWP) and CVP exports have the greatest effect on survival conditions for chinook salmon originating from the Mokelumne and San Joaquin rivers. The average annual survival conditions for young-of-year spring run is substantially lower than the average annual survival conditions for yearling spring run. The differences in survival conditions are primarily attributable to cooler water temperature conditions during the assumed young-of-year migration (February through April).

White and Green Sturgeon

In the Sacramento-San Joaquin River basins, white sturgeon primarily spawn in the mainstream Sacramento, San Joaquin, and Feather rivers. Very little information is available on the spawning distribution of green sturgeon. Survival and recruitment of sturgeon is related to river flow (i.e. higher flows are believed to improve spawning and rearing habitat conditions and increase dispersion of sturgeon larvae and juveniles).

Striped Bass

River flow, diversions, and estuarine salinity are the attributes for the No-Action Alternative that are included in the assessment of impacts on striped bass. The assessment of river flow, diversion, and salinity effects indicate that changes in water project operations could substantially change habitat conditions affecting striped bass in the Sacramento-San Joaquin River basins. The effects of diversions, including Delta agricultural diversions and CVP and SWP exports, on screenable life stages of striped bass (i.e., juveniles) are represented by the Delta diversion survival conditions. The variability in survival conditions can result from a variability in the volume and timing of diversions. When high diversions coincide with months of high vulnerability, annual Delta diversion survival conditions are relatively low.

Changes in Delta outflow, attributable primarily to variability in meteorology during the early life stages (April through July for striped bass), result in high annual variability in habitat area meeting salinity needs for the species/life stage. Upstream storage, upstream diversions, and Delta diversions also affect habitat availability.

Striped bass population abundance fluctuates in response to Delta outflow and CVP and SWP export. High abundance occurs following years of relatively low export and high Delta outflow and low abundance occurs following years of high export and low outflow.

American Shad

American shad, similar to striped bass, is primarily an estuarine species, spending most of its life in the Delta and Bay. River flow volume affects American shad abundance and survival by identifying habitat conditions. American shad juveniles emigrate through the Delta during September through December and are susceptible to entrainment in diversions. The variability in survival conditions results from fluctuations associated with the volume and timing of diversions.

When high diversions coincide with months of high vulnerability, the annual Delta diversion survival is relatively low.

Other Delta and Estuarine Species

Delta and estuarine species discussed in this PEIS include delta smelt, Sacramento splittail, longfin smelt, and bay shrimp. The Delta provides habitat for all life stages of Sacramento splittail and delta smelt and for spawning adult longfin smelt. Delta high-flow conditions during the splittail spawning and early rearing periods contribute to factors that increase population abundance. Delta and longfin smelt larvae are planktonic and entrainment in Delta diversions may be affected by the level of transport of water through the Delta. Effects of diversions on splittail larvae are less vulnerable than larval smelt to Delta diversions and were not included in the assessment.

A key factor affecting the abundance of delta smelt, longfin smelt, and bay shrimp is the availability of rearing habitat during the early life stages. All three species generally rear in habitat defined by specific salinity.

Reservoir Species

Under the simulated No-Action Alternative, reservoir operations and annual variability in hydrology result in a relatively wide range of habitat conditions for bass spawning and rearing. Depth and drawdown in reservoirs affect the variability of largemouth and spotted bass spawning and rearing survival conditions.

ALTERNATIVE 1

Chinook Salmon and Steelhead Trout

Alternative 1 conditions in the Sacramento-San Joaquin River basins would benefit chinook salmon and steelhead trout. Benefits would occur primarily through increased spawning habitat in Clear Creek and the Sacramento, American, and Stanislaus rivers, although, fry rearing habitat for late fall-run chinook salmon would be slightly reduced.

The increase in fall-run chinook survival stems from minor additional flows in the American River and Clear Creek that coincide with life stage occurrence. The reduction in the late fall-run fry rearing survival for Alternative 1 as compared to the No-Action Alternative is due to reduced average monthly flows during the late fall-run fry rearing period (April through August) in both the upper and middle Sacramento River.

Winter run incubation, fry rearing, and juvenile rearing survival conditions under Alternative 1 are very similar to those described under the No-Action Alternative. Increases in the juvenile rearing survival conditions were due to the slight increase in flow in the Calaveras River during the juvenile rearing period (September through November).

Increases in the spring run rearing survival conditions result from slight increases in Sacramento River flow during the rearing periods.

The increases in the steelhead trout spawning survival conditions under Alternative 1 as compared to the No-Action Alternative result from increased flow in Clear Creek and the American River during the steelhead trout spawning period.

The small increase in the steelhead trout rearing survival conditions under Alternative 1 results primarily from increased year-round flows in Clear Creek.

Relative to the No-Action Alternative, water temperature under Alternative 1 increases in the Sacramento River and reduces survival conditions of fall, late fall, and spring-run chinook salmon in the Sacramento River. Effects on survival of winter-run chinook salmon would be minimal because the system is operated for winter-run chinook salmon survival. Increased water temperature would also occur in the American River and would reduce survival of fall-run chinook salmon during spawning and incubation. Steelhead trout would benefit from temperature conditions under Alternative 1, although temperature conditions would adversely affect steelhead trout in the American River.

Under Alternative 1, diversion-related impacts on juvenile chinook salmon and steelhead trout would be reduced in streams and rivers of the Sacramento-San Joaquin River basins and in the Delta. Fish screen improvements, which may include elements to reduce entrainment, abrasion, handling stress, and diversion-related predation, is the main cause of increased diversion survival for Alternative 1 relative to the No-Action Alternative.

As previously discussed, the diversion survival conditions reflect an average condition and do not incorporate all factors that could affect the magnitude of diversion impacts, including diversion location, diversion structure, fish behavior, migration timing, and predation. The effects of diversions on survival of chinook salmon and steelhead trout focuses on the average timing of smolt emigration. Migration timing varies each year depending on water temperature, fish density, food availability, water turbidity, flow volume, and genetic variability. Winter-run chinook salmon have the highest annual survival conditions, with fall-run chinook salmon having the lowest. Winter-run chinook salmon emigrate during late fall and winter when diversions are relatively low and instream flows are potentially high. Fall-run chinook salmon emigrate during spring when both the proportion of instream flow diverted is high and instream flows are high.

Winter-run chinook salmon under the No-Action Alternative benefit the least from fish screen improvements implemented under Alternative 1. Fall-run chinook, have the lowest average annual survival conditions for the No-Action Alternative and experience the greatest change, under Alternative 1, from the No-Action Alternative; i.e., fall-run chinook gain the greatest direct benefit from screen improvements.

Among all riverine watershed compartments, increased survival of juvenile chinook salmon and steelhead trout are the greatest relative to the No-Action Alternative, due to changes in diversions in the upper and middle Sacramento River and the Yuba River. The relatively high proportion of the total chinook salmon and steelhead trout populations emigrating from the upper and middle Sacramento River and from the Yuba River, and the relatively high proportion of diverted river flow accounts for the high contribution of these watershed compartments to the increase in the river diversion survival conditions.

The American River is the only watershed compartment with an average annual diversion survival that is slightly lower under Alternative 1 than under the No-Action Alternative. The slight reduction in survival is a response to an increased proportion of flow diverted during the juvenile migration period under Alternative 1. The benefits of fish screen improvements are relatively small for the American River because the efficiency of existing fish screens is assumed to be relatively high (i.e., 85 percent of fish vulnerable to entrainment in a diversion would remain in the river in good condition).

Actions implemented under Alternative 1 would improve diversion survival conditions for all chinook salmon runs and for steelhead trout during emigration through the Delta. Spring-run chinook benefit the least of all runs from actions implemented under Alternative 1. Late fall-run chinook obtain the greatest direct benefit from fish screen improvements.

The change in average annual Delta pathway diversion survival under Alternative 1 reflects the benefits derived from flow changes, fish screen improvements, and Delta structures, including the Delta Cross Channel (DCC) gates, Georgiana Slough, and upper Old River. Late fall-run chinook salmon derive little benefit from Delta structures because the assumed timing of emigration for a substantial proportion of the population (October through December) precedes the timing of partial (November through January) and total (February through May) DCC and Georgiana Slough closure. The timing of migration for other chinook salmon runs and for steelhead trout generally coincides with closure of the DCC and Georgiana Slough and the benefits of structures is greater, with and without fish screens, relative to benefits described for late fall-run chinook salmon.

Comparisons of salmon survival conditions under Alternative 1, conditions as compared to the No-Action Alternative survival conditions, reflect changes in direct and indirect effects of Delta flow divisions, diversions, including SWP and CVP export, and water temperature. Salmon survival conditions are similar for juvenile salmon originating from the Sacramento River and for fall-run chinook in the Mokelumne River under Alternative 1 and No-Action Alternative conditions. Winter-run chinook salmon is the only Sacramento River run with notable benefits relative to the No-Action Alternative. For winter-run chinook salmon, benefits are attributable to the structural changes that prevent migration along pathways that subject juvenile salmon to higher mortality, including Georgiana Slough gates that prevent movement of juvenile salmon from the Sacramento River into the central Delta.

Delta survival conditions under Alternative 1 are beneficial to juvenile chinook salmon originating from the San Joaquin River. This benefit is attributable almost entirely to closure of the barrier at the head of Old River that forces juvenile salmon to migrate down the San Joaquin River and avoid direct exposure to increased mortality in the south Delta (i.e., increased exposure to the effects of SWP and CVP diversions).

White and Green Sturgeon

Flows simulated for Alternative 1 conditions would not affect riverine and Delta conditions for green sturgeon and white sturgeon relative to the No-Action Alternative. Implementing fish screen improvements under Alternative 1, however, may reduce diversion losses and increase survival conditions of sturgeon in the Delta.

For Alternative 1, the effects of diversions (including Delta agricultural diversions and CVP and SWP exports) on screenable life stages of sturgeon are substantially reduced relative to the No-Action Alternative. The improved survival conditions are attributable to fish screen improvements on all Delta diversions.

Striped Bass

Under Alternative 1, river flow conditions generally worsen for striped bass, and Delta survival conditions generally improve (with the exception of diversion effects on striped bass eggs and larvae). Survival of striped bass eggs spawned in the lower Sacramento River is correlated with river flow during May and June; higher flows increase survival, especially flows greater than 13,000 cubic feet per second (cfs). The flow reduction below 13,000 cfs averages 3,000 cfs and is the result of reduced exports, relative to the No-Action Alternative, from the Trinity River to the Sacramento River. Reduced Sacramento River flow could adversely affect spawning success of striped bass.

Conditions affecting diversions under Alternative 1 would adversely affect striped bass eggs and larvae and benefit screenable life stages. The reduction in the planktonic life stage diversion survival conditions is primarily attributable to reduced flow in the Sacramento River during peak occurrence of striped bass eggs and larvae (i.e., April and May) and closure of Georgiana Slough. Closure of Georgiana Slough, without reduced diversions and exports from the central and south Delta, increases flows that potentially contribute to increased entrainment (i.e., net flow toward Delta diversions increases in most of the spawning and early rearing habitats of striped bass). Structural changes to the Delta that benefit chinook salmon and steelhead trout would increase entrainment of planktonic life stages of striped bass.

For Alternative 1, the effects of diversions (including Delta agricultural diversions and CVP and SWP exports) on screenable life stages of striped bass are substantially reduced relative to the No-Action Alternative. The improved condition is attributable to fish screen improvements on all Delta diversions. Delta outflow and salinity habitat factors affecting Delta survival are unchanged under Alternative 1 relative to the No-Action Alternative.

Overall, striped bass population abundance would increase slightly under Alternative 1 conditions. The slight increase in the abundance survival is attributable to slight increases in outflow and changes in the timing of exports.

Delta operations could be adjusted to reduce adverse effects on striped bass eggs and larvae. Currently, the CALFED Delta operations group implements adaptive management strategies to improve Delta conditions for delta smelt, Sacramento splittail, winter-run chinook salmon, and other species. CALFED may include striped bass in development of management scenarios for Delta species. Delta structures (i.e., the DCC, potential Georgiana Slough gates, and the Old River barrier) could be operated based on the vulnerability of each species. When striped bass eggs and larvae are present in the central Delta and the lower San Joaquin River, the DCC and Georgiana Slough gates could be opened to avoid increasing net flows that potentially increase entrainment of eggs and larvae in the SWP and CVP Delta export facilities. When chinook salmon are present, the DCC and Georgiana Slough gates could be closed to prevent movement into the central Delta. When both species are present and DCC and Georgiana Slough operations

result in conflicting actions, exports could be reduced to temporarily improve migration and transport conditions during peak species vulnerability.

American Shad

Under Alternative 1, riverine habitat conditions for American shad would be similar to conditions under the No-Action Alternative. Entrainment in diversions would be substantially reduced by fish screen improvements and operations of Delta structures that would be implemented under Alternative 1.

The change in survival conditions in the Delta under Alternative 1 reflects the benefits derived from flow changes, fish screen improvements, and Delta structures.

For Alternative 1, the effects of diversions (including Delta agricultural diversions and CVP and SWP exports) on screenable life stages of American shad are substantially reduced relative to the No-Action Alternative. The improved condition is attributable to fish screen improvements on all Delta diversions.

Other Delta and Estuarine Species

Under Alternative 1, riverine and Delta habitat conditions would be nearly the same as those under the No-Action Alternative, except for the effects of diversion. Structural changes in the Delta would increase entrainment of larval delta and longfin smelt in Delta diversions and could adversely affect the populations. Fish screen improvements, however, would reduce entrainment losses of screenable life stages of delta smelt, longfin smelt, and Sacramento splittail.

Reservoir Species

Alternative 1 would affect surface elevation and drawdown in Whiskeytown Lake, Shasta Lake, Folsom Lake, and New Melones Reservoir. Implementing Alternative 1 would result in minimal changes to spawning and rearing habitat for bass compared to the No-Action Alternative, except for a slight increase in spawning habitat for largemouth bass in Folsom Lake.

ALTERNATIVE 2

Changes to most fishery resources under Alternative 2 as compared to the No-Action Alternative are similar to the changes discussed under Alternative 1. Improvements occur in spawning and rearing habitat for chinook salmon in the Stanislaus, Tuolumne, and Merced rivers due to increased flows.

Chinook Salmon and Steelhead Trout

Alternative 2 flow habitat conditions would benefit chinook salmon and steelhead trout in the Sacramento-San Joaquin River system. Benefits would occur primarily through increased spawning habitat in Clear Creek and the Sacramento, American, Merced, Tuolumne, and Stanislaus rivers. However, fry rearing habitat for late fall-run chinook salmon would be slightly reduced.

Relative to the No-Action Alternative, water temperature under Alternative 2 would increase in the Sacramento River, primarily related to lack of carry-over storage, and reduce survival of fall, late fall, and spring-run chinook salmon in the Sacramento River. Effects on survival of winter-run chinook salmon would be minimal. Increased water temperature would also occur in the American River and would reduce survival of fall-run chinook salmon during spawning and incubation. Steelhead trout would benefit from temperature conditions under Alternative 2, although temperature conditions would adversely affect steelhead trout in the American River. Simulated temperature conditions under Alternative 2 would result in effects similar to those described for Alternative 1.

Under Alternative 2, diversion-related impacts on juvenile chinook salmon and steelhead trout would be reduced in streams and rivers of the Sacramento-San Joaquin River basins and in the Delta. Fish screen improvement, which may include elements to reduce entrainment, abrasion, handling stress, and diversion-related predation, is the main cause of increased diversion survival conditions for Alternative 2 relative to the No-Action Alternative. In the Delta, an additional factor that reduces diversion-related effects relative to the No-Action Alternative is structural modification that forces migration through the Delta channels that support fewer diversions. Benefits to chinook salmon and steelhead trout under Alternative 2 are similar to those described in Alternative 1.

Salmon survival conditions for juvenile salmon originating from the Sacramento River (fall, late fall, winter, and spring runs) and from the Mokelumne River are similar for Alternative 2 and the No-Action Alternative. Winter-run chinook salmon is the only Sacramento River run with notable benefits relative to the No-Action Alternative. Benefits are attributable to the structural changes that prevent migration along pathways that subject juvenile salmon to higher mortality (i.e., Georgiana Slough gates prevent movement of juvenile salmon from the Sacramento River into the central Delta).

Delta conditions under Alternative 2 are clearly beneficial to juvenile chinook salmon originating from the San Joaquin River. The increase is attributable to closure of the barrier at the head of Old River that forces juvenile salmon to migrate down the San Joaquin River and avoid direct exposure to increased mortality in the south Delta (i.e., increased exposure to the effects of SWP and CVP diversions).

White and Green Sturgeon

Flows simulated for Alternative 2 conditions would not affect riverine and Delta conditions for white sturgeon and green sturgeon relative to the No-Action Alternative. Implementation of fish screen improvements under Alternative 2, however, may reduce diversion losses and increase survival of sturgeon in the Delta in a similar manner as described under Alternative 1.

Striped Bass

River flow conditions generally worsen for striped bass under Alternative 2 and Delta conditions generally improve (with the exception of diversion effects on striped bass eggs and larvae). Survival of striped bass eggs spawned in the lower Sacramento River is correlated with river

flow during May and June, especially for flows greater than 13,000 cubic feet per second. The flow reduction below 13,000 cubic feet per second averages 3,000 cubic feet per second and is the result of reduced exports, relative to the No-Action Alternative, from the Trinity River to the Sacramento River. During some years, reduced Sacramento River flow could adversely affect spawning success of striped bass. Substantial reduction in Sacramento River flow during May and especially June would reduce survival of striped bass eggs spawned in the Sacramento River.

Conditions affecting diversions under Alternative 2 would adversely affect striped bass eggs and larvae and benefit screenable life stages. The reduction in the planktonic life stages diversion survival is primarily attributable to reduced flow in the Sacramento River during peak occurrence of striped bass eggs and larvae (i.e., April and May) and closure of Georgiana Slough. Closure of Georgiana Slough, without reduced diversions and exports from the central and south Delta, increases transport flows that potentially contribute to increased entrainment (i.e., net flow toward Delta diversions increases in most of the spawning and early rearing habitat of striped bass).

For Alternative 2, the effects of diversions (including Delta agricultural diversions and CVP and SWP exports) on screenable life stages of striped bass are substantially reduced relative to the No-Action Alternative. The improved condition is attributable to fish screen improvements on all Delta diversions.

Other factors affecting Delta survival are unchanged or improved under Alternative 2 relative to the No-Action Alternative.

American Shad

Under Alternative 2, riverine habitat conditions for American shad would be similar to conditions described under the No-Action Alternative, with the exception that entrainment in diversions, would be substantially reduced by fish screen improvements and operations of Delta structures as described under Alternative 1.

Overall, flow in rivers of the Sacramento-San Joaquin River basins and spawning conditions for American shad would be approximately the same as flow and conditions under the No-Action Alternative. Under Alternative 2, the average simulated Delta inflow does not change, and the abundance survival conditions would not change.

With respect to Alternative 2, the average simulated flow in the Sacramento and American rivers generally decreases in May through June; Mokelumne River flow generally increases; and Feather and Stanislaus river flow remains the same as for the simulated No-Action Alternative. The flow habitat survival conditions for the Feather and Mokelumne rivers are identical to the corresponding No-Action Alternative, but the flow habitat survival for the Sacramento and American rivers decrease from the No-Action Alternative. The Stanislaus River flow habitat survival increases relative to the No-Action Alternative.

Actions implemented under Alternative 2 improve diversion survival conditions for American shad during emigration through the Delta. Benefits of fish screen improvements and Delta structures (i.e., DCC, Georgiana Slough) under Alternative 2 are the same as described for

American shad in Alternative 1. For Alternative 2, the effects of diversions on screenable life stages of American shad (i.e., the Delta diversion survival condition) is the same as described for Alternative 1.

Other Delta and Estuarine Species

Under Alternative 2, riverine and Delta habitat conditions would be nearly the same as conditions under the No-Action Alternative, except for the effects of diversion. Structural changes in the Delta would increase entrainment of larval delta and longfin smelt in Delta diversions and could adversely affect the populations. Fish screen improvements, however, would reduce entrainment losses of screenable life stages of delta smelt, longfin smelt, and Sacramento splittail.

Higher Delta outflows also indicate improved splittail spawning and rearing habitat. Alternative 2 flow habitat conditions would benefit Sacramento splittail in the Sacramento-San Joaquin River system similar to the benefits described in Alternative 1.

The reduction in diversion survival of the planktonic life stages for delta smelt and longfin smelt, relative to the No-Action Alternative, is primarily attributable to closure of Georgiana Slough and is the same as described for Alternative 1.

The absence of structural improvements that were constructed to benefit chinook salmon results in conditions for delta and longfin smelt that are better than those under the No-Action Alternative.

For Alternative 2, the effects of diversions (including Delta agricultural diversions and CVP and SWP exports) on screenable life stages of delta and longfin smelt, and Sacramento splittail, are substantially reduced.

Structural changes to the Delta that benefit chinook salmon and steelhead trout would increase entrainment of planktonic life stages of delta and longfin smelt.

Delta smelt, longfin smelt, and bay shrimp rearing habitat is defined by specific salinity ranges. The available habitat area is determined by the location of the salinity ranges in the estuary during the rearing period for each species. Salinity habitat availability under Alternative 2 simulated conditions, which is dependent on Delta outflow, is slightly increased from the No-Action Alternative but similar to conditions described under Alternative 1. Therefore, slightly more rearing habitat is available to delta and longfin smelt. The mean annual optimal salinity habitat survival for bay shrimp are similar to the survival conditions for the No-Action Alternative.

Reservoir Species

In addition to the flow drawn from Whiskeytown Lake, Shasta and Folsom Lakes, and New Melones Reservoir, Alternative 2 would require releases from New Don Pedro Reservoir and Lake McClure, and additional flow from New Melones Reservoir. Alternative 2 conditions result in minimal changes in spawning and rearing survival conditions for bass and are similar to those described in Alternative 1.

ALTERNATIVE 3

Changes to most fishery resources under Alternative 3 as compared to the No-Action Alternative are similar to the changes discussed under Alternative 1 for the Sacramento River system. Improvements do occur in spawning and rearing habitat for chinook salmon in the Stanislaus, Tuolumne, and Merced rivers due to increased flows. In addition, increased survival conditions for sturgeon and abundance for striped bass and American shad occur due to increased Delta outflow as compared to No-Action Alternative and Alternatives 1 and 2.

Chinook Salmon and Steelhead Trout

Alternative 3 flow habitat conditions would benefit chinook salmon and steelhead trout in the Sacramento-San Joaquin River system. Benefits would occur primarily through increased spawning habitat in Clear Creek and the Sacramento, American, Merced, Tuolumne, and Stanislaus rivers. Fry rearing habitat for late fall-run chinook salmon would be slightly reduced. The magnitude of benefits and adverse impacts would be relatively small and would primarily occur on the San Joaquin River tributaries.

Relative to the No-Action Alternative, and due in part to a lack of reservoir carryover-storage, water temperature under Alternative 3 would increase in the Sacramento River and reduce survival conditions of fall, late fall, and spring-run chinook salmon. Effects on survival conditions of winter-run chinook salmon would be minimal as compared to the No-Action Alternative. Water temperature would also increase in the American River and would reduce survival of fall-run chinook salmon during spawning and incubation. Steelhead trout would benefit from temperature conditions under Alternative 3 although temperature conditions would adversely affect steelhead trout in the American River. Simulated temperature conditions under Alternative 3 would result in effects similar to those described for Alternative 1.

Under Alternative 3, diversion-related impacts on juvenile chinook salmon and steelhead trout would be reduced in streams and rivers of the Sacramento-San Joaquin River basins and in the Delta. Fish screen improvement, that may include elements to reduce entrainment, abrasion, handling stress, and diversion-related predation, is the main cause of increased diversion survival conditions for Alternative 3 relative to the No-Action Alternative. In the Delta, an additional factor that reduces diversion-related effects relative to the No-Action Alternative is structural modification that forces migration through the Delta channels that support fewer diversions. Benefits to chinook salmon and steelhead trout under Alternative 3 are similar to the benefits described in Alternative 1.

Survival conditions for juvenile salmon originating from the Sacramento River (fall, late fall, winter, and spring runs) and from the Mokelumne River are similar for Alternative 3 and the No-Action Alternative. Winter-run chinook salmon is the only Sacramento River run with notable benefits relative to the No-Action Alternative. Benefits are attributable to the structural changes that prevent migration along pathways that subject juvenile salmon to higher mortality (i.e., Georgiana Slough gates prevent movement of juvenile salmon from the Sacramento River into the central Delta).

Delta conditions under Alternative 3 are clearly beneficial to juvenile chinook salmon originating from the San Joaquin River. The increase survival conditions is attributable to closure of the barrier at the head of Old River that forces juvenile salmon to migrate down the San Joaquin River and avoid direct exposure to increased mortality in the south Delta (i.e., increased exposure to the effects of SWP and CVP diversions).

White and Green Sturgeon

Flows simulated for Alternative 3 conditions would improve riverine and Delta conditions for white sturgeon and green sturgeon relative to the No-Action Alternative. Implementation of fish screen improvements under Alternative 3, may further reduce diversion losses and increase survival of sturgeon in the Delta.

Increased flows in the San Joaquin River under Alternative 3 may improve spawning conditions for sturgeon. Increased flows in the San Joaquin River could provide a slight benefit to sturgeon under Alternative 3.

For Alternative 3, the effects of diversions (including Delta agricultural diversions and CVP and SWP exports) on screenable life stages of sturgeon are substantially reduced relative to the No-Action Alternative. The improved survival condition is attributable to fish screen improvements on all Delta diversions. Without fish screen improvements, there is no change in the diversion survival conditions between Alternative 3 and the No-Action Alternative.

Striped Bass

River flow conditions generally worsen for striped bass under Alternative 3 and Delta conditions generally improve as compared to the No-Action Alternative. The increase in the planktonic life stage diversion survival is primarily attributable to increased flow in the San Joaquin River during peak occurrence of striped bass eggs and larvae (i.e., April and May). Closure of Georgiana Slough, without reduced diversions and exports from the central and south Delta, may increase transport flows that potentially contribute to increased entrainment in Delta diversions. Increased San Joaquin River flow, alleviates the adverse effects of Georgiana Slough closure on striped bass entrainment under Alternative 3.

For Alternative 3, the effects of diversions (including Delta agricultural diversions and CVP and SWP exports) on screenable life stages of striped bass are substantially reduced relative to the No-Action Alternative. The improved condition is attributable to fish screen improvements on all Delta diversions.

Other factors affecting Delta survival are improved under Alternative 3 relative to the No-Action Alternative. Delta outflow during the early rearing period for striped bass (i.e., April through July), increases under Alternative 3 conditions. Salinity habitat availability under Alternative 3 conditions is greater than habitat availability for the No-Action Alternative.

Striped bass population abundance would increase under Alternative 3 conditions. The increase in the abundance is attributable to increased Delta outflow and changes in the timing of exports.

American Shad

Overall, flow in rivers of the Sacramento-San Joaquin River basins increase slightly, but spawning conditions for American shad would be about the same as conditions under the No-Action Alternative. Under Alternative 3, simulated Delta inflow increases slightly and the annual abundance for American shad would increase.

The average simulated flows in the Sacramento and American rivers generally decrease in May through June relative to the No-Action Alternative; the Stanislaus River simulated flows generally increase; and the Feather and Mokelumne River simulated flows remain the same as the No-Action Alternative. Average annual habitat survival conditions for the Feather and Mokelumne rivers are identical for the No-Action Alternative and Alternative 3. The American River habitat conditions decreases, Sacramento River habitat conditions is reduced, and the habitat conditions for the Stanislaus River increases.

Actions implemented under Alternative 3 improve diversion survival for American shad during emigration through the Delta. Benefits of fish screen improvements and Delta structures (i.e., DCC, Georgiana Slough) under Alternative 3 are the same as described for American shad in Alternative 1. For Alternative 3, the effects of diversions on screenable life stages of American shad (i.e., the Delta diversion survival condition) is the same as described for Alternative 1.

Other Delta and Estuarine Species

Under Alternative 3, riverine and Delta habitat conditions would generally improve relative to conditions under the No-Action Alternative. Structural changes in the Delta would increase entrainment of larval longfin smelt in Delta diversions and could adversely affect the population. Fish screen improvements would reduce entrainment losses of screenable life stages of delta smelt, longfin smelt, and Sacramento splittail.

Higher Delta outflows also promote improved splittail spawning and rearing habitat. Alternative 3 flow habitat conditions would benefit Sacramento splittail in the Sacramento-San Joaquin River system. The overflow habitat survival is the same for both Alternative 3 and the No-Action Alternative.

Delta smelt, longfin smelt and bay shrimp rearing habitat is defined by specific salinity ranges. The available habitat area is determined by the location of the salinity ranges in the estuary during the rearing period for each species. Salinity habitat availability under Alternative 3 simulated conditions, which is dependent on Delta outflow, is greater than habitat availability under the No-Action Alternative.

Reservoir Species

In addition to the flow released under Alternative 2 (from Whiskeytown Lake, Shasta and Folsom lakes, New Melones and New Don Pedro reservoirs, and Lake McClure), Alternative 3 would also require additional flow releases from New Melones and New Don Pedro reservoirs and Lake McClure. Alternative 3 conditions would result in minimal changes as compared to the

No-Action Alternative in spawning and rearing conditions for bass, except for a decrease in largemouth bass spawning success in Folsom Lake, due to reservoir drawdown.

ALTERNATIVE 4

Chinook Salmon and Steelhead Trout

Alternative 4 conditions would benefit most chinook salmon and steelhead trout life stages in the Sacramento-San Joaquin River system. Benefits would occur primarily through increased spawning habitat in Clear Creek and the Sacramento, American, Merced, Tuolumne, and Stanislaus rivers, although fry rearing habitat for winter-run and late fall-run chinook salmon would be slightly reduced.

Relative to the No-Action Alternative, water temperature under Alternative 4 would increase in the Sacramento River and reduce survival of fall, late fall , and spring-run chinook salmon. Effects on survival of winter-run chinook salmon would be minimal. Water temperature would also increase in the American River and would reduce survival of fall-run chinook salmon during spawning and incubation. Steelhead trout would benefit from temperature conditions under Alternative 4, although temperature conditions would adversely affect steelhead in the American River. Simulated temperature conditions under Alternative 4 would result in similar effects as described for Alternative 1.

Under Alternative 4, diversion-related impacts on juvenile chinook salmon and steelhead trout would be reduced in streams and rivers of the Sacramento-San Joaquin River basins and in the Delta. Fish screen improvement, which may include elements to reduce entrainment, abrasion, handling stress, and diversion-related predation, is the main cause of increased diversion survival for Alternative 4 relative to the No-Action Alternative. In the Delta, an additional factor that reduces diversion- related effects relative to the No-Action Alternative is structural modification directing migration through the Delta channels associated with fewer diversions. Benefits to chinook salmon and steelhead trout under Alternative 4 are similar to the benefits described in Alternative 1.

Survival conditions for juvenile salmon originating from the Sacramento River (fall, late fall, winter, and spring-runs) and from the Mokelumne River are similar for Alternative 4 and the No-Action Alternative. Winter- and spring-run (young-of-year migrants) chinook salmon benefit more than other Sacramento River runs relative to the No-Action Alternative. Benefits are attributable to increased Sacramento River flow and structural changes that prevent migration along pathways that subject juvenile salmon to higher mortality (i.e., Georgiana Slough gates prevent movement of juvenile salmon from the Sacramento River into the central Delta).

Delta conditions under Alternative 4 are clearly beneficial to juvenile chinook salmon originating from the San Joaquin River. The increase is attributable to closure of the barrier at the head of Old River that forces juvenile salmon to migrate down the San Joaquin River and avoid direct exposure to increased mortality in the south Delta (i.e., increased exposure to the effects of SWP and CVP diversions). Salmon survival without the Old River barrier were similar to conditions for the No-Action Alternative, however, increased flow in the San Joaquin River during juvenile

chinook salmon migration improved the survival conditions relative to flows under the No-Action Alternative.

White and Green Sturgeon

Flows simulated for Alternative 4 conditions would improve riverine and Delta conditions for white sturgeon and green sturgeon relative to the No-Action Alternative (i.e., similar to improvements described under Alternative 3). Implementation of fish screen improvements under Alternative 4 may reduce diversion losses and increase survival of sturgeon in the Delta.

Striped Bass

Under Alternative 4, striped bass spawning success would be reduced as compared to No-Action Alternative because Sacramento River flow is less, although Delta conditions improve. Entrainment in Delta diversions would be reduced and striped bass abundance would increase, due to increased flows from the Sacramento and San Joaquin rivers and eastside streams.

American Shad

Under Alternative 4, riverine habitat conditions for American shad spawning would improve relative to conditions under the No-Action Alternative. Entrainment in diversions would be substantially reduced by fish screen improvements and operations of Delta structures that would be implemented under Alternative 4.

Overall, spawning conditions for American shad would improve because of increased flow in rivers of the Sacramento-San Joaquin River basins. In Alternative 4, simulated Delta inflow increases slightly and the annual abundance of American shad would increase.

Benefits of fish screen improvements and Delta structures (i.e., DCC, Georgiana Slough) under Alternative 4 are the same as described for American shad in Alternative 1.

Other Delta and Estuarine Species

Under Alternative 4, riverine and Delta habitat conditions would generally improve relative to conditions under the No-Action Alternative. Reductions in entrainment of larval longfin smelt in Delta diversions would be similar to those described for Alternative 3. Fish screen improvements would reduce entrainment losses of screenable life stages of delta smelt, longfin smelt, and Sacramento splittail.

Higher Delta outflows also improved splittail spawning and rearing habitat. Alternative 4 flow habitat conditions would benefit Sacramento splittail in the Sacramento-San Joaquin River system.

For Alternative 4, the reduction in the planktonic life stage of longfin smelt, relative to the No-Action Alternative, is primarily attributable to closure of Georgiana Slough. The conditions for the planktonic life stage of delta smelt is the same for both Alternative 4 and the No-Action

Alternative. Improvements are attributable primarily to increased Delta inflow from the San Joaquin River.

Reservoir Species

Alternative 4 conditions would result in minimal reduction in spawning and rearing conditions for bass, except for largemouth bass spawning in Folsom Lake, as discussed under Alternative 1. As with the spawning conditions, Alternative 4 conditions have little effect on the bass rearing conditions.

ALTERNATIVE 5

Adverse impacts on chinook salmon and steelhead trout also occur under Alternative 5 simulations. Changes in operation of New Melones Reservoir and Lake Oroville would adversely affect water temperature conditions for chinook salmon and steelhead trout in the Stanislaus and Feather rivers. Drawdown of New Melones and New Don Pedro reservoirs, Lake McClure, and Millerton Lake would adversely affect spawning and rearing habitat of reservoir species.

Other actions that could improve habitat conditions under Alternative 5 include removing Red Bluff Diversion Dam (RBDD) gates for the entire year, removing Woodbridge Dam on the Mokelumne River, constructing additional fish screen improvements in the Delta (e.g., fish screens at the Pacific Gas and Electric Company (PG&E) generating facilities), reducing predator species populations, and removing additional barriers to fish migration.

Chinook Salmon and Steelhead Trout

Alternative 5 conditions would benefit most chinook salmon and steelhead trout life stages in the Sacramento-San Joaquin River system. Benefits would occur primarily through increased spawning habitat in Clear Creek and the Sacramento, Feather, American, Calaveras, Merced, Tuolumne, and Stanislaus rivers.

Relative to the No-Action Alternative, water temperature under Alternative 5 would decrease and result in increased temperature survival conditions for all species in most rivers. The Feather and Stanislaus rivers are the exception where water temperature increases and negatively affects temperature survival.
The temperature survival in the Feather River is reduced relative to the corresponding survival conditions in the No-Action Alternative. Water temperature in the upper Feather River increases during late spring and early fall and adversely affects juvenile fall-run chinook salmon spawning, rearing, and migration. Increased water temperature during late spring and summer would also reduce the temperature survival conditions for steelhead trout in the Feather River.

In the Stanislaus River, temperature conditions resulting from minimal carryover storage would worsen and substantial adverse impacts could occur for fall-run chinook salmon, and are substantially less than the corresponding conditions for the No-Action Alternative. Reduced temperature survival for the Stanislaus River is attributable to increased fall water temperature that would affect adult migration, spawning, and incubation. Juvenile rearing of steelhead trout

would also be reduced, although the temperature survival conditions would increase for the steelhead because of improved water temperature during spring and early summer when spawning, incubation and fry rearing occur. Increased fall water temperature results from drawdown of New Melones Reservoir to meet spring instream and Delta flow needs.

The removal or modification of Old Melones Dam is included in AFRP recommendations for Alternative 5 to improve fall water temperatures in the Stanislaus River. Due to the limitations of the Bureau's temperature model used to simulate Stanislaus River temperature conditions, this action is not included in the temperature analysis for Alternative 5.

Similar temperature effects could be expected for the Merced and Tuolumne rivers. Water temperature was not simulated for the Merced and Tuolumne rivers, but similar adverse effects might occur in response to spring drawdown of Lake McClure and New Don Pedro Reservoir. The combination of drawdowns and minimal carryover storage could reduce temperature survival conditions, and could worsen the adverse impacts for fall-run chinook salmon.

Under Alternative 5, diversion-related impacts on juvenile chinook salmon and steelhead trout would be reduced in streams and rivers of the Sacramento-San Joaquin River basins and in the Delta. Fish screen improvement, which may include elements to reduce entrainment, abrasion, handling stress, and diversion-related predation, and substantially reduced diversions, are the main causes of increased diversion survival conditions for Alternative 5 relative to the No-Action Alternative. Fish screen improvements provide minimal benefits under Alternative 5 because the proportion of flow diverted is relatively small relative to diversions under the No-Action Alternative. In the Delta, an additional factor that reduces diversion-related effects relative to the No-Action Alternative is structural modification that forces migration through Delta channels that support fewer diversions.

Among all riverine watershed compartments, changes to diversions in the upper and middle Sacramento River and the Yuba River have the greatest benefit to juvenile chinook salmon and steelhead trout relative to the No-Action Alternative. The relatively high proportion of the total chinook salmon and steelhead trout populations emigrating from the upper and middle Sacramento River and from the Yuba River, and the relatively high proportion of river flow diverted, accounts for the high contribution of these watershed compartments to the improved in the river diversion survival.

Under Alternative 5, fish screen improvements provide notable benefits for fall and late fall-run chinook salmon. Spring-run chinook salmon under the No-Action Alternative benefit the least from actions, i.e., fish screen improvements and Delta structures, implemented under Alternative 5. Late fall-run chinook gain the greatest direct benefit from fish screen improvements. Fall and winter-run chinook salmon and steelhead trout each have an increase in survival conditions.

The changes in survival conditions under Alternative 5 reflects the benefits derived from reduced diversions, flow changes, fish screen improvements, and Delta structures (i.e., DCC, Georgiana Slough, and upper Old River). Delta structures and fish screen improvements, however, provide minimal benefits under Alternative 5 because of the substantial reduction in Delta diversions and substantial increase in inflow.

Salmon survival conditions for juvenile salmon originating from the Sacramento River (fall, late fall, winter, and spring runs) and from the Mokelumne River increase under Alternative 5 conditions. For chinook salmon originating from the Sacramento river, benefits are attributable primarily to structural changes that prevent migration along pathways that subject juvenile salmon to higher mortality (i.e., Georgiana Slough gates that prevent movement of juvenile salmon from the Sacramento River into the central Delta) and to increased Sacramento River flow. Chinook salmon originating from the Mokelumne River would benefit primarily from reduced Delta diversions (i.e., primarily reduced CVP and SWP exports).

Delta conditions under Alternative 5 are beneficial to juvenile chinook salmon originating from the San Joaquin River, over the No-Action Alternative. The increase is attributable to increased flow in the San Joaquin River, closure of the barrier at the head of Old River (i.e., with structural improvements), and reduced Delta diversions, including reduced CVP and SWP exports. With structural improvements, the barrier at the head of Old River reduces exposure to the SWP and CVP diversions, forcing migration down the San Joaquin River past Stockton. Reduced diversions and increased flow also improve habitat conditions in the south Delta.

White and Green Sturgeon

Flows simulated for Alternative 5 conditions would improve riverine and Delta conditions for green sturgeon and white sturgeon relative to the No-Action Alternative. Increased Delta inflow, substantially reduced diversions, and implementation of fish screen improvements under Alternative 5 would reduce diversion losses and increase survival of sturgeon in the Delta.

Striped Bass

River flow and Delta conditions are substantially improved under Alternative 5. Increased Sacramento River flow would improve egg survival. Increased Delta inflow, reduced Delta diversions, and fish screen improvements would substantially reduce diversion losses of all life stages (i.e., eggs, larvae, and juveniles). Increased Delta outflow would substantially increase estuarine habitat availability and the combination of increased Delta outflow and substantially reduced CVP and SWP exports would increase striped bass abundance.

American Shad

Under Alternative 5, riverine habitat conditions for American shad would substantially improve relative to conditions under the No-Action Alternative. Entrainment in diversions would be substantially reduced by increased Delta inflow, reduced diversions, fish screen improvements, and operations of Delta structures.

Other Delta and Estuarine Species

Under Alternative 5 conditions, riverine and Delta habitat conditions would improve substantially relative to conditions under No-Action Alternative. Increased Sacramento River flow would increase habitat availability for Sacramento splittail. Increased Delta inflow and reduced Delta diversions would substantially reduce entrainment losses of all life stages (i.e.,

larvae, juveniles, and adults) of Sacramento splittail, delta smelt, and longfin smelt Increased Delta outflow would increase estuarine habitat for delta smelt, longfin smelt, and bay shrimp.

Reservoir Species

Alternative 5 flow needs would affect several reservoirs. In addition to the flow released for flow needs common to Alternative 4 (i.e., from Whiskeytown Lake, Shasta and Folsom lakes, Lake Oroville, New Hogan Lake, New Melones and New Don Pedro reservoirs, and Lake McClure), Alternative 5 would require additional flow from Shasta and Folsom lakes, Lake Oroville, New Hogan Lake, New Melones and New Don Pedro reservoirs, and Lake McClure. Alternative 5 would drastically reduce flows to the San Luis Reservoir.

Alternative 5 conditions would substantially reduce spawning and rearing habitat conditions for bass in New Melones and New Don Pedro reservoirs, Lake McClure, and Millerton Lake. Although San Luis Reservoir surface elevations would be substantially lower under Alternative 5 relative to the No-Action Alternative, spawning and rearing habitat conditions would substantially improve because of reduced annual drawdown. Spawning and rearing habitat in other reservoirs in the Sacramento-San Joaquin River basins would be unchanged or increase slightly as compared to the No-Action Alternative.

SURFACE WATER FACILITIES AND SUPPLIES

This section provides a summary of potential impacts to water supplies that would result from the implementation of the preliminary alternatives considered in the PEIS as compared to the No-Action Alternative. The PEIS preliminary alternatives include several component actions that would affect the availability of water supplies to CVP water users. These include the reoperation of CVP facilities and dedication of CVP water supplies toward meeting the Draft AFRP Plan target flows, the retirement of land pursuant to the San Joaquin Valley Drainage Plan, and the acquisition of water from willing sellers for delivery to wildlife refuges, increased instream flows, and increased Delta outflow.

For each preliminary alternative, the simulated operation of CVP facilities, SWP facilities, and local water supply project facilities to accomplish the objectives of the alternative are discussed. The analysis focuses primarily on the operation of surface water supply facilities, and describes changes in reservoir storage conditions, releases from reservoirs, deliveries of surface water pursuant to CVP and SWP contracts, and acquisition quantities.

NO-ACTION ALTERNATIVE

The No-Action Alternative is described in the Draft PEIS in Chapter 2. Operations under the No-Action Alternative are influenced significantly by the 1993 Winter-run chinook salmon Biological Opinion, except for the "QWEST requirement" which was replaced with conditions contained in the 1995 Water Quality Control Plan. The biological opinion addresses temperature control objectives for several CVP operational objectives and Keswick operations for flow fluctuation. The biological opinion specifies that Reclamation maintain a minimum end-of-water year (September 30) carryover storage of 1.9 million acre-feet in Shasta Lake. This storage has

been judged by National Marine Fisheries Service (NMFS) and DFG to be attainable in all but critical and extremely critical water year types. When CVP operations forecast project that carryover storage levels in Shasta Lake may drop below 1.9 million AF at the end of the water year or non-conformance with temperature control objectives, Reclamation re-initiates consultation with NMFS prior to the first water allocations announcement.

Operations under the No-Action Alternative also was significantly influenced by Stanislaus River operations. Historically, Reclamation has had difficulty meeting all of the operational obligations on New Melones Reservoir. This difficulty became pronounced during the drought conditions of 1987-1992, which resulted in water levels in New Melones Reservoir as low as approximately 80,000 acre-feet. During that drought period, Reclamation met frequently with Stanislaus River stakeholders to coordinate operational objectives to manage the limited supplies.

In the No-Action Alternative, it is anticipated that a long-term operation for the management of water on the Stanislaus River would be developed. Therefore, the operations of New Melones Reservoir in the No-Action Alternative are assumed to follow with the priorities established in the State Water Resources Control Board Decision 1422 (D-1422) and subsequent agreements. D-1422 stipulates that New Melones Reservoir be operated to provide water to satisfy existing diversion water rights, provide minimum instream flows on the Stanislaus River, and release water from New Melones to attempt to attain water quality objectives on the Stanislaus and San Joaquin rivers. After these conditions are met, additional releases from New Melones Reservoir as necessary to comply with the San Joaquin River flow requirements specified in 1995 Bay-Delta Plan Accord. In years where all of these conditions are met, water would be allocated for delivery pursuant to CVP contracts.

ALTERNATIVE 1

Alternative 1 contains three significant components that affect operations of the CVP and reduce the available water supply to CVP contractors. These include the (b)(2) Water Methodology, the increase in water deliveries to wildlife refuge to provide Level 2 supplies, and the reduced exports from the Trinity River Basin that would occur due to implementation of a modified Trinity River flow pattern.

In the development of the (b)(2) Water Methodology, flow conditions in the No-Action Alternative simulation were compared to the Draft AFRP Plan target flows. This comparison was used to identify locations and times where target flows would not be met under the No-Action Alternative conditions, and to develop operational objectives to meet the target flows where possible. The following sections describe the comparison of No-Action Alternative simulated conditions to the Draft AFRP Plan target flows for CVP-controlled streams, and describes the operations implemented toward meeting the target flows.

Clear Creek Operations

As developed by Reclamation, the minimum flows on Clear Creek are:

- Jan. 1 through Oct. 31: 50 cfs (normal year) or 30 cfs (critical year); and

- Nov 1 through Dec. 31: 100 cfs (normal year) or 70 cfs (critical year).

In the No-Action Alternative simulation, both normal and critical year minimum flow requirements are 50 cfs from January 1 through October 31.

The Draft AFRP Plan target flows on Clear Creek were prescribed for fall/late-fall chinook salmon and steelhead as well as spring-run salmon and are specified as 200 cfs from October through May (regardless of water year type) and 150 cfs for the remainder of the year (variable spring-time releases depending on water year type). During drought conditions, a 25 percent reduction in instream flow is allowed.

The Draft AFRP Plan minimum instream flow requirements for Clear Creek are prescribed for every month of the year, based on water year-type. The Shasta Index year-type is used. In critically dry years, inflow to Whiskeytown Lake is insufficient to support Draft AFRP Plan flow requirements so the flow requirements are reduced to maintain minimum storage levels in Clair Engle and Whiskeytown lakes.

The No-Action Alternative simulation flows meet Draft AFRP Plan target flows on Clear Creek in less than 10 percent of the months of all year types. The Shasta Index was used for this comparison. This indicates that re-operation and/or dedication of CVP yield would be necessary to meet target flows. However, hydrology and limited reservoir storage capacity restrict the ability to re-operated water and dedicate CVP yield.

During the 1928 through 1934 critical dry period, winter and spring inflows to Whiskeytown Lake often exceed the releases needed to meet target flows. Limited reservoir storage makes it difficult to store this water for use in subsequent dry months when inflows are significantly less than the releases needed to meet target flows. In addition, the "excess" inflows are smaller in storable quantity than the additional releases necessary to meet target flows.

During these dry periods water exported from the Trinity River is minimal. Exports from the Trinity River are already reduced to maintain minimum Clair Engle Lake storage. Outside of the critical dry period, inflows to Whiskeytown and Trinity River exports are sufficient to meet target flows.

Given the above constraints to re-operation and dedication of CVP yield, it is not possible to meet all Draft AFRP Plan target flows on Clear Creek. Through consultation with Reclamation and the Service, priorities for re-operation and dedication of CVP yield were established. The minimum flow requirements in critical dry years were reduced to 30 percent of target flows. These target flows are used in the (b)(2) Water Management simulation. Minimum storages in Clair Engle and Whiskeytown lakes are not violated during any year type. Draft AFRP Plan target flows are met in all but critical years, thereby minimizing the impacts on storage in Clair Engle and Whiskeytown lakes and temperature control.

Sacramento River Operations

The operational criteria included in the No-Action Alternative are in accordance with the Winter-run chinook salmon Biological Opinion, as summarized below.

- Maintain minimum carryover (end-of-September) storage of 1.9 million acre-feet in Shasta Lake, except in the driest ten percent of years.

- Maintain temperature control below Keswick Dam from May 1 through September 30.

- Maintain minimum flow of 3,250 cfs below Keswick Dam from October 1 through March 31. NMFS will consider variation from this requirement on a case by case basis when drought conditions threaten human health and safety.

The Draft AFRP Plan target flows on the Sacramento River at Keswick Dam were developed to balance instream flow needs for habitat with carryover storage needs for temperature control. Flow stability for winter-run chinook salmon rearing and spring/fall-run chinook spawning was a consideration. The minimum flow requirement at Keswick for October through April is based on the October 1 storage in Shasta Lake. A storage target of 3.0 through 3.2 million acre-feet is set for April 30 to maintain enough water for summer temperature control.

The No-Action Alternative simulation flows range from meeting the Draft AFRP Plan target flows on the Sacramento River at Keswick Dam in nearly all of the months during October through April in wet years to 50 percent of the months during October through April in dry years. This indicates that in many years, the target flows would be achieved without the need for additional re-operation.

Unlike the No-Action Alternative simulation, in the (b)(2) water management simulation the October through April target flows are based on October 1 storage in Shasta Lake and are therefore achieved in 100 percent of the months. Increases in monthly flows during this period are generally the result of the releases to meet target flows.

Re-operation in the (b)(2) water management simulation involves utilizing Shasta Lake storage to increase October through April river flows. Shasta Lake releases are "shifted" from the spring and summer months to the fall and winter months. This shift in releases is limited by the need to make releases for winter run temperature control during the spring and summer.

In all but critical low runoff years which follow wet years, operations under the storage/flow relationship results in reasonable April 30 Shasta Lake storages (between 3.0 and 3.2 million acre-feet).

The end-of-water year storage targets as set in the Winter-run chinook salmon Biological Opinion can be met in all but some dry and critical dry years. The target cannot be met in some critical years because reservoir inflows are extremely low and spring and summer reservoir releases are required for temperature control and water rights deliveries.

In many dry and critical dry years, CVP reservoir releases for fisheries purposes (including the biological opinion and Delta water quality requirements) govern CVP operations north of the Delta. Export pumping is often limited to incidental Delta inflows.

American River Operations

Existing operational criteria are presented below. Temperature control on the American River is not an operational constraint in the PEIS analysis.

- Maintain U.S. Army Corps of Engineers (COE) Folsom flood control requirements of 400,000 acre-feet.

- Maintain flows below Nimbus Dam based on available storage in Folsom Lake pursuant to a historical operational practice informally referred to as "Modified D-1400."

The Draft AFRP target flows were developed to provide adequate flow for the fall/winter spawning and incubation of chinook salmon and steelhead trout. The availability of water associated with each year type was considered. A September 30 Folsom Lake carryover storage target of 610,000 acre-feet was included to provide a sufficient volume and cold water pool to maintain spawning and incubation flows during the fall and winter months. The need to reduce and control flow fluctuations to minimize adverse effects on juvenile salmonids was also recognized.

The No-Action Alternative simulation flows meet Draft AFRP Plan target flows on the American River below Nimbus Dam in 60 percent of the months in wet years and in 20 percent of the months in critical dry years. Because there is no American River year-type index, the 40-30-30 Index was used for this comparison. During the fall and winter months when flow fluctuations should be minimized, all target flows are met in 10 percent of the October through February periods in above normal years and in zero percent of the same periods during dry and critical dry years. The reservoir carryover storage target is met in 40 percent of the years. These results indicate that re-operation and/or dedication of CVP yield would be necessary to meet the target flows. However hydrology, demands at a projected 2020 level of development, and limited reservoir storage capacity limit the ability to re-operate water and dedicate CVP yield.

Throughout the 69-year hydrology, Folsom Lake inflows are highly variable, ranging from less than 1 million acre-feet to greater than 6 million acre-feet. With such a variable hydrology, inflows in wet years will often exceed the releases needed to meet target flows. The limited storage in Folsom Lake (the capacity is 972 thousand acre-feet) makes it difficult to store this water for use in subsequent dry years when inflows may be significantly less than the releases needed to meet target flows. In addition, flood control restrictions will often require the release of storage water.

Demands along the American River also limit the ability to re-operate and dedicate CVP yield. Between projected 1995 and 2020 levels of development, municipal and industrial (M&I) demands along the American River increased from 240 thousand acre-feet to 510 thousand acre-feet. The majority of the increase in demands is for water rights contractors and cannot be dedicated toward meeting the target flows. This water is released on a monthly pattern to meet water rights demands, which usually do not coincide with Draft AFRP Plan monthly target flows.

Given the above constraints to re-operation and dedication of CVP yield, it is not possible to meet all Draft AFRP Plan target flows on the lower American River. Through consultation with Reclamation and the Service, priorities for re-operation and dedication of CVP yield were established. The year-type flow requirements were transformed into reservoir storage-based flow requirements to allow additional operational flexibility during dry and critical years. The reach of the river over which the requirement applied was changed to below Nimbus Dam to "H" Street. The Service's flow priority was to establish stable fall and winter flows October through February and increase Folsom Lake end-of-month September storage. Minimum flows for the October through February period are based on October 1 storage in Folsom Lake. Flow requirements for the remaining months, March through September, are tied to the previous month's storage and remaining water year projected inflow. Target spring pulse flows in the March through June months are considered to be a lower priority than the October through February target flows.

The storage-based flow relationship is used in the (b)(2) Water Management simulation. In comparison to the No-Action Alternative simulation, reservoir releases in all water year types are shifted from the spring and summer months to the fall and winter months, in accordance with the prioritized target flows. For the October through February period, target flows (year-type based) are achieved in 100 percent of the October through February periods of wet, above normal, and below normal years. For the same period, target flows are met in 80 percent of the dry years and 40 percent of critically dry years.

Reductions in spring and summer releases from Folsom Lake consequently reduce its contribution to Delta water quality requirements. This places an addition burden on Shasta Lake to meet these requirements. In addition, the flow reductions during spring and summer months increase end-of-September carryover storages by an average of 80 thousand acre-feet. The AFRP Plan Folsom Lake carryover storage target is met in 50 percent of the years.

Stanislaus River Operations

The primary operational criteria governing the operations of New Melones Reservoir in Alterative 1 are the same as those described in the No-Action Alternative.

Draft AFRP Plan Target Flows for the Stanislaus River are intended to supplement instream flow releases described in the No-Action Alternative.

In the No-Action Alternative, the monthly flows generally meet the Draft AFRP Plan target flows in the summer, fall, and winter months in approximately 50 percent of the months. However, the spring pulse flows would be met only in very wet conditions, when releases are made to maintain flood control storage. Therefore, the re-operation of New Melones Reservoir and (b)(2) Water Methodology on the Stanislaus River focused on these two objectives and was accomplished in two steps.

The first step included operation of New Melones Reservoir to meet the Draft AFRP Plan target flows in July through March during non-critical years. Because this operation would generally result in lower storage conditions in New Melones Reservoir, operational flow targets were initially reduced in April through June in order to maintain minimum New Melones Reservoir

storage criteria. Due to the limited water supplies, no increase in the instream flows would be made in critical year types.

To attempt to restore flows during the April through June period to conditions in the No-Action Alternative, the second step applied the (b)(2) water methodology to CVP contracts. In years when the Draft AFRP Plan target flows would not be met, no water would be delivered under the CVP contracts. This water would be stored in New Melones Reservoir and released toward meeting the target flows deficits, primarily in April through June. In addition, where possible, flood control ramping releases in the summer and fall would be released earlier in the year, primarily in April through June to help meet Draft AFRP Plan target flow deficits.

Upper San Joaquin River Operations

The Draft AFRP Plan recommends the development of actions that would result in increased flows on the mainstem San Joaquin River. The increased flows are interpreted as target conditions on the San Joaquin River at Vernalis and would not apply to the San Joaquin River above the confluence with the Merced River. Therefore the operations of the Friant Division in Alternative 1 would be the same as the No-Action Alternative.

Impacts to CVP Operations and Deliveries

A comparison of deliveries to CVP contractors in the Alternative 1 simulation, as compared to deliveries in the No-Action Alternative simulation is provided in Table III-1. A discussion of the operations of CVP facilities, and deliveries to CVP contractors north of the Delta, south of the Delta, on the Stanislaus River, and in the Friant Division, are provided in the following sections.

TABLE III-1

COMPARISON OF CVP DELIVERIES IN THE ALTERNATIVE 1 AND NO-ACTION ALTERNATIVE SIMULATIONS

Contract Years	Type of Period	Simulated Average Annual CVP Deliveries (1,000 acre-feet)		Average Annual Change in CVP Deliveries (1,000 acre-feet)
		No-Action Alternative	Alternative 1	
1922 - 1990	Simulation Period	5,770	5,300	-470
1928 - 1934	Dry Period	4,560	4,050	-510
1967 - 1971	Wet Period	6,310	6,020	-290

(b)(2) Water Component of Alternative 1. The (b)(2) water was used to meet the Bay-Delta Plan Accord requirements and to help meet the draft AFRP Plan target flows in all years. The greatest amount of water is dedicated in dry and below normal hydrologic periods. The average annual measurement of (b)(2) water would be less than 800,000 acre-feet during all of the hydrologic periods considered in this analysis. This would occur because the Draft AFRP

target flows are met in wetter years through reservoir releases in the No-Action Alternative operations, and no additional releases or dedication of water would be necessary. Conversely, the greatest need for (b)(2) water occurs during dry periods when natural river flows and reservoir releases are at their lowest. During dry years the use of (b)(2) water is limited by low reservoir water supplies, minimum reservoir storage requirements, and other competing water needs including water rights and releases for winter-run chinook salmon temperature control on the Sacramento River below Keswick Dam.

Clair Engle Lake Storage. On an average annual basis, end-of-year storage is 200,000 acre-feet less in Alternative 1 than the No-Action Alternative. This reduction in storage results from the increase in Trinity River instream flow requirements. Clair Engle Lake storage is also reduced because of its low refill potential.

Exports from the Trinity River Basin. Exports from the Trinity River Basin are decreased an average of 200,000 acre-feet on an annual basis.

Clear Creek Flows. Draft AFRP Plan target flows are achieved in all but critically dry years.

Shasta Lake Storage. Reservoir carryover storages in Alternative 1 are lower than those in the No-Action Alternative because of the decrease in Trinity River exports. The reduction in exports limits the ability to use Trinity water to offset spring releases from Shasta Lake and maintain its cold water pool for temperature control during the summer. The reduction in Trinity River exports requires more water to be released from Shasta Lake to meet minimum contract obligations and temperature control requirements.

Sacramento River Below Keswick Dam Flows. Alternative 1 reservoir releases are shifted, to the extent possible, from the spring and summer months to the fall and winter months to meet Draft AFRP target flows. The year-round decrease in Alternative 1 flows is due primarily to the decrease in Trinity River exports. Alternative 1 average flows in the fall and winter months are also lower than those in the No-Action Alternative, due in part to the increase in Folsom Lake releases to meet American River Draft AFRP target flows. The October through April Keswick target flows are based on October 1 storage in Shasta Lake and are therefore achieved in 100 percent of the months.

Although there are no Draft AFRP Plan target flows from May 1 through September 30, reservoir releases are still required during this period to meet winter run temperature control requirements.

Folsom Lake Storage. The increase in reservoir storage is primarily the result of the AFRP Plan end-of-year storage goal incorporated in (b)(2) Water Management on the American River.

American River Below Nimbus Dam Flows. Reservoir releases are shifted from the spring and summer months to the fall and winter months, in accordance with the prioritized target flows. The Draft AFRP Plan target flows during the October through February period are achieved in 100 percent of the periods in wet, above normal, and below normal years. For the same period, target flows are met in 80 percent of the dry years and 40 percent of the critical dry years.

New Melones Reservoir Storage. In general, reservoir storage levels are lower in Alternative 1 than in the No-Action Alternative. This is due to the fact that higher instream flows are released from New Melones Reservoir in the non-critical years. Because no increases in instream flows are provided during critical years, the Alternative 1 storages during those years are approximately the same as the No-Action Alternative.

Flows in the Stanislaus River Below Goodwin Dam. In Alternative 1, New Melones Reservoir would be operated to meet Draft AFRP Plan target flows from July through March in non-critical years. Because the primary emphasis for use of (b)(2) water and re-operation is in the April through June period, average monthly flows increase during these months. Elevated flows during the summer and fall months result from releases made for instream and Vernalis water quality requirements.

San Joaquin River Water Quality at Vernalis. During both the irrigation and non-irrigation seasons, the frequency with which water quality exceeds the standard increases in Alternative 1 as compared to the No-Action Alternative. This occurs because the delivery of Level 2 water supplies to wildlife refuges in the San Joaquin Valley would result in increased return flows, and increased salinity concentration.

Flows in the San Joaquin River at Vernalis. Changes in flows on the San Joaquin River near Vernalis resulting from modified Stanislaus River operations in Alternative 1 would be relatively small compared to the cumulative flow at Vernalis.

Millerton Lake Storage and San Joaquin River Flows at Stevinson. Millerton Lake storages and San Joaquin River flows at Stevinson are similar to the No-Action Alternative.

Exports through Tracy Pumping Plant. In comparison to the No-Action Alternative, the average annual reduction in exports is 260,000 acre-feet. The reduction in pumping is due to changes in the timing of upstream reservoir releases to meet the AFRP goals, the reduction in Trinity exports, and the increase in deficiencies applied to CVP deliveries south of the Delta. Reservoir releases are decreased in the spring and summer months when pumping capacity is available at Tracy. However, reservoir releases are then increased in the fall and winter months to help meet Draft AFRP Plan target flows. These flow increases into the Delta cannot always be pumped by Tracy because there is often no excess pumping capacity available.

CVP San Luis Reservoir Storage. Alternative 1 CVP storage in San Luis Reservoir is similar to that of the No-Action Alternative.

Deliveries to CVP Agricultural Water Service Contractors North of the Delta. Full contract deliveries occur in approximately 70 percent of the years in both simulations. Delivery of at least 85 percent of full water service contracts is reduced from 85 percent of the years in the No-Action Alternative to 75 percent of the years in Alternative 1. In the No-Action Alternative, the minimum delivery is 15 percent of full water service contracts. In Alternative 1, no deliveries to water service contractors are made in 5 percent of the years. The reductions in agricultural water service contract deliveries in Alternative 1 are due to the cumulative effects of (b)(2) water, Firm Level 2 refuge water supplies, and the decrease in exports from the Trinity River.

Deliveries to CVP Settlement and Exchange Contractors. Deliveries to Sacramento River Settlement and the San Joaquin River Exchange contractors are unchanged from the No-Action Alternative.

Deliveries to CVP Municipal Water Service Contractors North of Delta. Full contract delivery is reduced from approximately 85 percent of the years in the No-Action Alternative to 75 percent of the years in Alternative 1. The minimum delivery of 75 percent of full water service contracts occurs in 10 percent of the years in the No-Action Alternative and 20 percent of the years in Alternative 1.

Deliveries to CVP Agricultural Water Service Contractors South of the Delta. Full contract delivery is reduced from approximately 50 percent of the years in the No-Action Alternative to 30 percent in Alternative 1. In the No-Action Alternative, the minimum delivery is 10 percent of full water service contracts. In Alternative 1, no deliveries to water service contractors are made in 5 percent of the years.

Deliveries to CVP Municipal Water Service Contractors South of the Delta. Full contract delivery is reduced from approximately 70 percent of the years in the No-Action Alternative to 45 percent of the years in Alternative 1. The minimum delivery of 75 percent of full water service contracts occurs in 15 percent of the years in the No-Action Alternative and 45 percent of the years in Alternative 1.

Deliveries to CVP Agricultural Water Service Contractors on the Stanislaus River. Under Alternative 1, partial or full deliveries to long-term renewable water service contractors on the Stanislaus River would be made in approximately 20 to 30 percent of the years. This is less than the simulated delivery of full contract amounts during approximately 40 percent of the years in the No-Action Alternative. The reduction in deliveries results from the use of (b)(2) water to help meet Draft AFRP Plan target flows in the Stanislaus River.

Diversions to the Madera and Friant-Kern Canals. Because the objectives in Alternative 1 do not affect the operations of Millerton Lake, the diversions to the Madera Canal and Friant Kern Canal are similar to the No-Action Alternative.

CVP Water Deliveries To Refuges. Alternative 1 includes delivery of firm Level 2 water supplies to refuges. There is an increase of about 180,000 acre-feet in alternative 1 annual refuge deliveries as compared to the No-Action Alternative. The 25 percent deficiency to refuge deliveries in critical dry years is based on the Shasta Criteria, as it is in the No-Action Alternative.

Impacts to SWP Operations and Deliveries

A comparison of deliveries to SWP contractors in the Alternative 1 simulation, as compared to deliveries in the No-Action Alternative simulation is provided in Table III-2. A discussion of the operations of SWP facilities, and deliveries to SWP contractors is provided in the following sections.

TABLE III-2

COMPARISON OF SWP DELIVERIES IN THE ALTERNATIVE 1 AND NO-ACTION ALTERNATIVE SIMULATIONS

Contract Years	Type of Period	Simulated Average Annual SWP Deliveries (1,000 acre-feet)		Average Annual Change in SWP Deliveries (1,000 acre-feet)
		No-Action Alternative	Alternative 1	
1922 - 1990	Simulation Period	3,330	3,430	+100
1928 - 1934	Dry Period	2,050	2,200	+150
1967 - 1971	Wet Period	4,140	4,100	-40

Lake Oroville Storage. The small differences in Lake Oroville storage are result of operational changes in response to changes in the availability of excess water in the Delta, as a function of (b)(2) water management and reduced exports from the Trinity River. These operational changes may require different reservoir releases to meet Coordinated Operations Agreement (COA) obligations or Delta water quality requirements.

Feather River Flows Below Gridley and Nicolaus. Simulated average monthly flows in the Feather River below Gridley and Nicolaus are similar to the No-Action Alternative.

Exports through Banks Pumping Plant. In comparison to the No-Action Alternative, the average annual increase in exports is 70,000 acre-feet. As discussed in (b)(2) water management, Delta inflows during fall and winter months are increased because of greater reservoir releases for Draft AFRP Plan target flows. In many years, the additional inflows exceed the pumping capacity of Tracy Pumping Plant. Pumping capacity is available at Banks, and the SWP is able to increase exports without additional releases from Lake Oroville.

SWP San Luis Reservoir Storage. Alternative 1 SWP storage in San Luis Reservoir is similar that of the No-Action Alternative.

Deliveries to SWP Entitlement Holders South of the Delta. Full contract delivery occurs in 40 percent of the years in both simulations. Deliveries of at least 95 percent of full entitlements is increased from approximately 45 percent of the years in the No-Action Alternative to 55 percent of the years in Alternative 1. In Alternative 1, the minimum delivery increases to 20 percent of full entitlements from 15 percent in the No-Action Alternative. These increases in entitlement deliveries in Alternative 1 are due to increased fall and winter SWP pumping through Banks Pumping Plant.

Delta Outflow

In comparison to the No-Action Alternative simulation, average annual Delta outflows in Alternative 1 would be reduced by approximately 60 thousand acre-feet. These flows reflect changes upstream of the Delta (e.g., releases from Shasta and Folsom lakes and Whiskeytown

and New Melones reservoirs for Draft AFRP Plan target flows, reductions in exports from the Trinity River). However, the flow changes are small in proportion to total Delta outflows.

ALTERNATIVE 2

In Alternative 2, water would be acquired for two purposes: Level 4 refuge water supplies and instream flows on the Stanislaus, Tuolumne, and Merced rivers. Level 4 refuge water supplies would be acquired from sources with reliable, consistent water supplies located close to the refuges where possible. Water acquired on the Stanislaus, Tuolumne, and Merced rivers would be used to partially meet Draft AFRP Plan salmon and steelhead target flows on these streams, primarily in April through June, and to provide increased Delta outflow. Because this water would be acquired for both instream flows and Delta outflow, it would not be pumped by export facilities in the Delta. It is recognized that the release of acquired water to increase flows on the Stanislaus, Tuolumne, and Merced rivers would result in increased flows in the San Joaquin River at Vernalis. Increased flows during April and May would decrease the number of occurrences when the Bay-Delta Plan Accord pulse flow requirements on the San Joaquin River at Vernalis would not be met.

Water Acquisitions for Draft AFRP Target Flows and Delta Outflow

In Alternative 2, surface water would be acquired from willing sellers on the Stanislaus, Tuolumne, and Merced rivers. For the purposes of this analysis, it is assumed that the maximum quantity of water to be acquired from each source would be the same in all years. This assumption approximates a condition of a long term acquisition agreement that would stipulate a maximum annual quantity. The quantity of water that would be acquired on each river would be limited to either the maximum acquisition quantity assumed in the alternative, or the maximum quantity needed to meet the Draft AFRP Plan instream target flows for the particular year, whichever is less. As a condition of water acquisition, it is assumed that the reduction in surface water deliveries to sellers could not be offset with additional groundwater pumping.

In Alternative 2, the maximum acquisition of water from willing sellers for instream flows on the Stanislaus, Tuolumne, and Merced rivers would be 60,000, 60,000, and 50,000 acre-feet, respectively. The acquisition of up to 50,000 acre-feet from sources on the Merced River would occur in addition to an acquisition of 19,000 for Level 4 refuge water supplies to the Merced NWR and East Gallo Unit. On the Stanislaus River, acquisitions would range from 0 to 60,000 acre-feet; the maximum acquisition quantity of 60,000 acre-feet would be acquired in approximately 70 to 80 percent of the years. Acquisition quantities range from 36,000 to 60,000 acre-feet on the Tuolumne River, and from 0 to 50,000 acre-feet on the Merced River. The maximum acquisition quantities of 60,000 acre-feet on the Tuolumne, and 50,000 acre-feet on the Merced would be acquired in nearly all of the years.

It is assumed that water would be acquired from water rights holders that possess diversion and storage rights on these rivers. The acquired water would be stored during the period of a contract year, and released in a manner to increase flows toward meeting the AFRP instream flow targets and to increase Delta outflow. In effect, the acquisition of water would involve a shift in the release pattern from storage reservoirs, combined with a reduction in the diversion of the released water.

To avoid unintended impacts to downstream water users not involved in the sale or acquisition of water, base flow conditions would be maintained at the No-Action Alternative level in rivers that would be affected by the use of acquired water.

To the extent that the water quality standards would be exceeded, portions of water acquired in Alternative 2 would be released in a manner to maintain the water quality conditions equal to the No-Action Alternative on a percent frequency basis.

Impacts to CVP Operations and Deliveries

This section provides a comparison of conditions under Alternative 2 to the No-Action Alternative. The discussion focuses on reservoir operations, resulting releases, and deliveries of water to CVP contractors. With the exceptions of four groups of water users, deliveries to CVP water users north and south of the Delta are similar to those in Alternative 1. Deliveries to Sacramento River Water Rights Settlement Contractors, Delta Mendota Canal Exchange Contractors, diversions on the Friant-Kern Canal, and diversions on the Madera Canal are similar to those in the No-Action Alternative.

Reservoir Operations and Flow. Under surface water acquisitions for Draft AFRP target flows and refuge water supplies in Alternative 2, reservoir operations in Clair Engle Lake, Shasta Lake, Folsom Lake, and CVP portion San Luis Reservoir would be similar to those described in Alternative 1. Releases from those reservoirs on the Sacramento River below Keswick and Grimes, the American River below Nimbus Dam, and Clear Creek would be similar to those described in the Alternative 1. Exports from the Trinity River Basin and through Tracy Pumping Plant would be similar in those described in Alternative 1.

New Melones Reservoir Storage. In general, reservoir storage levels in non-critical years would be lower in Alternative 2 than in the No-Action Alternative due to higher releases for instream flows. Storage levels during critical years would be similar to the No-Action Alternative. Acquisition and use of surface water on the Stanislaus River in Alternative 2 would result in little or no change in end-of-water year storage levels in New Melones Reservoir.

Flows in the Stanislaus River Below Goodwin Dam. Releases of acquired water would increase flows primarily in the April through June period. On an average monthly basis, flows would meet Draft AFRP Plan target flows in nearly all months of above and below normal, dry, and critical year types. Although average monthly flows increase in the April through June period in wet year types, they would not meet the Draft AFRP Plan target flows.

San Joaquin River Water Quality at Vernalis. Under Alternative 2 operations, water quality at Vernalis would exceed the applicable water quality standard the same or less frequently than in the No-Action Alternative.

Millerton Lake Storage and San Joaquin River Flows at Stevinson. In Alternative 2, Millerton Lake storages and San Joaquin River flows at Stevinson are similar to the No-Action Alternative.

Flows in the San Joaquin River at Vernalis. In the months of July through March, average monthly flows in Alternative 2 would be similar to those in the No-Action Alternative. In the April through June period, however, the releases of acquired water on the Stanislaus, Tuolumne, and Merced rivers would result in increased flows on the San Joaquin River at Vernalis. In general, average monthly flows at Vernalis would meet the Draft AFRP Plan target flows during the July through March period. Although the use of acquired water would result in increased flows during April through June, average monthly flows in these months would not meet the Draft AFRP Plan target flows.

Deliveries to CVP Agricultural Water Service Contractors on the Stanislaus River. Deliveries to CVP agricultural water service contractors in Alternative 2 would be similar to deliveries in Alternative 1.

Impacts to SWP Operations and Deliveries

Alternative 2 includes the same (b)(2) water methodology as described in Alternative 1, and the acquisition of water from willing sellers. In this alternative, it is assumed that the SWP would not participate as a willing seller. In addition, the release of acquired water would be prescribed for instream flows and Delta outflow. Therefore, releases from Lake Oroville, flows on the Feather River, exports through Banks Pumping Plant, and deliveries to SWP agricultural and M&I entitlement holders would be similar to those described for Alternative 1.

Resulting Streamflows from the Release of Acquired Water on Non-CVP Controlled Streams

Tuolumne River Below La Grange Dam. Releases of acquired water would increase flows primarily in the April through June period. In general, average monthly flows would meet Draft AFRP Plan target flows in some fall and winter months. However, target flows could not be met with the acquisition of water supplies specified in Alternative 2.

Merced River Below Crocker Huffman Diversion. Releases of acquired water would increase flows primarily in the April through June period. However, target flows could not be met with the acquisition of water supplies specified in Alternative 2.

Delta Outflow

In Alternative 2, the primary change is the acquisition of water on the Stanislaus, Tuolumne, and Merced rivers. The average annual increase in Delta outflow is 80 thousand acre-feet.

ALTERNATIVE 3

Alternative 3 includes the acquisition of water on the Stanislaus, Tuolumne, and Merced rivers to attempt to meet Draft AFRP Plan salmon and steelhead target flows on these streams, primarily the in February through June period, and to provide increased Delta outflow. Because this water would be acquired for both instream flows and Delta outflow, it would not be pumped by export facilities in the Delta. It is recognized that the release of acquired water to increase flows on the Stanislaus, Tuolumne, and Merced rivers would result in increased flows in the San Joaquin

River at Vernalis. Increased flows during April and May would decrease the number of occurrences when the Bay-Delta Plan Accord pulse flow requirements on the San Joaquin River at Vernalis would not be met.

It is also recognized that the purpose of this alternative is to meet target flows from the Draft AFRP Plan which had been subject to the reasonableness criteria. However, the Service was still conducting this analysis at the time of the preparation of the Draft PEIS, and target flows evaluated for reasonableness were not available for use in the Draft PEIS. Therefore, the target flows from the Draft AFRP Working Paper were used in the analysis for this alternative analysis for non-CVP controlled streams. It is recognized that CVPIA requires application of reasonableness criteria for all implementation actions. Therefore, any alternative ultimately implemented under CVPIA, must by law, incorporate the use of such criteria.

Water Acquisitions for Draft AFRP Target Flows and Delta Outflow

In Alternative 3, surface water would be acquired from willing sellers on the Stanislaus, Tuolumne, and Merced rivers, and would be released in a manner to help meet Draft AFRP Plan target flows on these streams, and increase Delta outflow. The methodology that would be used to acquire water in Alternative 2 would also be applied to water acquisitions in Alternative 3.

In Alternative 3, maximum acquisition quantities for instream flows on the Stanislaus, Tuolumne, and Merced rivers are 135,000, 790,000, and 355,000 acre-feet respectively. On the Stanislaus River, acquisitions would range from 0 to 135,000 acre-feet. These values are smaller than on the other rivers because the target flow values were reduced from the Draft Working Paper values through the use of the reasonableness criteria. Values for the Tuolumne and Merced rivers have not been subjected to reasonableness criteria. Water would be acquired on the Stanislaus river in approximately 85 percent of the years, and the maximum quantity of 135,000 acre-feet would be acquired in approximately 15 percent of the years. On the Tuolumne River, acquisition quantities would range from 418,000 to 790,000 acre-feet. Water would be acquired on the Tuolumne River in all years, and the maximum quantity would be acquired in approximately 60 percent of the years. On the Merced River, acquisition quantities would range from 169,000 to 355,000 acre-feet. Water would be acquired in all years, and the maximum quantity would be acquired in approximately 60 percent of the years.

Impacts to CVP Operations and Deliveries

Alternative 3 CVP operations and deliveries would be similar to those described in Alternative 2. With the exceptions of five groups of water users, deliveries to CVP water users north and south of the Delta are similar to those in Alternative 1. Deliveries to Sacramento River Water Rights Settlement Contractors, Delta Mendota Exchange Contractors, diversions on the Friant-Kern Canal, and diversions on the Madera Canal are similar to those in the No-Action Alternative. Deliveries to CVP Contractors are described below.

Reservoir Operations and Flow. Under surface water acquisitions for Draft AFRP target flows in the Alternative 3 simulation, reservoir operations in Clair Engle Lake, Shasta Lake, Folsom Lake, and CVP portion San Luis Reservoir are similar to those in the Alternative 1 simulation. Releases from those reservoirs on the Sacramento River below Keswick and Grimes,

the American River below Nimbus Dam, and Clear Creek are similar to those in Alternative 1. Exports from the Trinity River Basin and through Tracy Pumping Plant are similar in those of Alternative 1.

New Melones Reservoir Storage. In some months of non-critical years, reservoir storage levels would be lower in Alternative 3 than in the No-Action Alternative due to higher reservoir releases for instream flows. In other months, however, monthly storage levels in New Melones Reservoir would be higher in Alternative 3 than in the No-Action Alternative due to lower releases for Vernalis water quality requirements. The effects of higher releases for instream flows and lower releases for Vernalis water quality may be offsetting in many years. Draft AFRP Plan target flows would be met in the July through March period. Since there would be no need to store acquired water beyond the month of June to meet flow needs in later months, surface water acquisition on the Stanislaus River would have little additional effect on the end-of-water year storage in New Melones Reservoir as compared to the No-Action Alternative.

Flows in the Stanislaus River Below Goodwin Dam. The releases of acquired water would increase flows primarily in the April through June period. Decreases in flows during the summer and fall months of non-critical years would result from lower releases for Vernalis water quality. Flows in the Stanislaus River below Goodwin Dam would meet the Draft AFRP Plan target flows in all months.

San Joaquin River Water Quality at Vernalis. Water quality conditions at Vernalis would be improved compared to the No-Action Alternative, and would meet the standards in nearly all months of the simulation period. The improved water quality conditions result of from increased flows due to the release of acquired water on the Merced, Tuolumne, and Stanislaus rivers. The release of acquired water on these rivers would increase flows on the San Joaquin river in all months of the year.

Millerton Lake Storage and San Joaquin River Flows at Stevinson. In Alternative 3, Millerton Lake storages and San Joaquin River flows at Stevinson are similar to the No-Action Alternative.

Flows in the San Joaquin River at Vernalis. On an average monthly basis, flows on the San Joaquin River at Vernalis would increase in nearly all months of all year types due to releases of acquired water the Stanislaus, Tuolumne, and Merced rivers. Because the emphasis for use of acquired water on these three rivers are in the April through June period, the resulting flows at Vernalis would increase the greatest during those months. In general, average monthly flows at Vernalis in Alternative 3 would meet the Draft AFRP Plan target flows during the July through March period.

Deliveries to CVP Agricultural Water Service Contractors on the Stanislaus River. Deliveries to CVP agricultural water service contractors in Alternative 3 would be similar to deliveries in Alternative 1.

Impacts to SWP Operations and Deliveries

SWP operations and deliveries in Alternative 3 are very similar to Alternatives 1 and 2. Releases from Lake Oroville, flows on the Feather River, exports through Banks Pumping Plant, and deliveries to SWP agricultural and M&I entitlement holders would be similar to those described for Alternative 1.

Resulting Streamflows from the Release of Acquired Water on Non-CVP Controlled Streams

Tuolumne River Below La Grange Dam. The releases of acquired water would result in increases in average monthly flows in all months of all years, with the largest increases occurring in February through June. In general, average monthly flows would meet Draft AFRP Plan target flows in below normal, dry, and critical years. Average monthly flows would meet the target flows in July through April in the wet and above normal years.

Merced River Below Crocker Huffman Diversion. The releases of acquired water would result in increases in average monthly flows in all months of all years, with the largest increases occurring in February through June. In general, average monthly flows would meet Draft AFRP Plan target flows in below normal, dry, and critical years. Average monthly flows would meet the target flows in July through April in the wet and above normal years.

Delta Outflow

In Alternative 3, the primary change is surface water acquisition for Draft AFRP Plan target flows. The acquired water cannot be exported out of the Delta for southern deliveries, so the average annual increase in Delta outflow is about 860 thousand acre-feet. These flow increases mainly occur in the spring months.

ALTERNATIVE 4

Under Alternative 4, water would be acquired for instream flows on the Stanislaus, Tuolumne, Merced, Calaveras, Mokelumne, and San Joaquin rivers as well as in the Feather River Basin. Water acquisition in Alternative 4 includes the acquisition of the same quantities of water to provide Level 4 refuge water supplies as described in Alternative 2. A description of the assumptions for the acquisition of water in Alternative 4 is provided below.

Water Acquisitions for Draft AFRP Target Flows and Delta Outflow

In Alternative 4, surface water would be acquired from willing sellers on the Stanislaus, Tuolumne, Merced, Calaveras, and Mokelumne rivers and willing sellers in the Feather River Basin, and would be released in a manner to help meet Draft AFRP Plan target flows on these streams, and increase Delta outflow. The methodology that would be used to acquire water in Alternative 2 would also be applied to water acquisitions in Alternative 4.

In Alternative 4, maximum acquisition quantities for instream flows on the Stanislaus, Tuolumne, Merced, Calaveras and Mokelumne rivers would be 135,000, 790,000, 355,000,

27,000, and 99,000 acre-feet, respectively. In addition, up to 182,000 acre-feet would be acquired annually from willing sellers in the Feather River Basin to improve instream flows on the Feather and Yuba rivers. These maximum quantities were selected based on instream flow needs determined from a comparison of No-Action Alternative simulated flows and Draft AFRP Plan target flows.

Impacts to CVP Operations and Deliveries

Alternative 4 CVP operations and deliveries to CVP contractors would be similar to those described in Alternative 1.

Under surface water acquisitions for Draft AFRP target flows in the Alternative 4 simulation, reservoir operations in Clair Engle Lake, Shasta Lake, Folsom Lake, and CVP portion San Luis Reservoir are similar to those in the Alternative 1 simulation. Releases from those reservoirs on the Sacramento River below Keswick and Grimes, the American River below Nimbus Dam, and Clear Creek are similar to those in Alternative 1. Exports from the Trinity River Basin and through Tracy Pumping Plant are similar in those of Alternative 1.

New Melones Reservoir Storage. In some months, reservoir storages are lower in Alternative 4 than in the No-Action Alternative. This is due to the fact that higher instream flows are released from New Melones Reservoir in the non-critical years as compared to the No-Action Alternative. In other months during the simulation period, monthly storages in New Melones Reservoir are higher in Alternative 4 than in the No-Action Alternative. The higher storages are a result of lower releases for Vernalis water quality requirements. Smaller releases would be needed to maintain water quality conditions at Vernalis in Alternative 4 than the No-Action Alternative, because the use of acquired water on the Tuolumne and Merced rivers would provide additional flows in the San Joaquin River, thereby improving the water quality conditions at Vernalis.

Flows in the Stanislaus River Below Goodwin Dam. Releases of acquired water would increase flows primarily in the April through June period. Decreases in flows during the summer and fall months of non-critical years would also result from lower releases for Vernalis water quality requirements, as described above. Flows in the Stanislaus River below Goodwin Dam would meet the Draft AFRP Plan target flows in all months. In some months, particularly the April through June period, Stanislaus River flows would exceed the Draft AFRP Plan target flows due to additional releases of acquired water to help meet target flows on the San Joaquin River at Vernalis.

San Joaquin River Water Quality at Vernalis. Water quality conditions at Vernalis would be improved compared to the No-Action Alternative, and would meet the standards in nearly all months of the simulation period. The improved water quality conditions result from increased flows due to the release of acquired water on the Merced, Tuolumne, and Stanislaus rivers. The release of acquired water on these rivers would increase flows on the San Joaquin river in all months of the year.

Millerton Lake Storage and San Joaquin River Flows at Stevinson. Because the objectives in Alternative 4 do not affect operations of Millerton Lake, simulated monthly storages are similar to the No-Action Alternative.

Flows in the San Joaquin River at Vernalis. On an average monthly basis, flows on the San Joaquin River at Vernalis would increase in nearly all months of all year types due to releases of acquired water the Stanislaus, Tuolumne, and Merced rivers. Because the emphasis for use of acquired water on these three rivers are in the April through June period, the resulting flows at Vernalis would be largest in those months. In general, average monthly flows at Vernalis would meet the Draft AFRP Plan target flows during the July through March period.

Deliveries. Under surface water acquisitions for Draft AFRP target flows in the Alternative 4 simulation, deliveries to CVP agricultural and M&I water service contractors north and of the Delta are similar to those in the Alternative 1 simulation. Deliveries to CVP agricultural and M&I water service contractors south of the Delta in Alternative 4 are similar to those in Alternative 1 because the acquired water cannot be exported out of the Delta for southern deliveries. Deliveries to CVP Settlement and Exchange Contractors in Alternative 4 are similar to those in the No-Action Alternative.

Deliveries to CVP Agricultural Water Service Contractors on the Stanislaus River. Because the additional acquisition on the Stanislaus River in Alternative 4 would result in relatively little change in New Melones Reservoir operations, the deliveries to CVP agricultural water service contractors on the Stanislaus River in Alternative 4 are similar to those in Alternative 1.

Diversions to the Madera and Friant-Kern Canals. Because the objectives in Alternative 4 do not affect the operations of Millerton Lake, the diversions are similar to the No-Action Alternative.

Impacts to SWP Operations and Deliveries

Alternative 4 includes the same (b)(2) water methodology as described in Alternative 1, and additional acquisition of water from willing sellers. In this alternative, it is assumed that the SWP would not participate as a willing seller. In addition, the release of acquired water would be prescribed for instream flows and Delta outflow. Therefore, releases from Lake Oroville, exports through Banks Pumping Plant, and deliveries to SWP agricultural and M&I entitlement holders would be similar to those described for Alternative 1.

Resulting Streamflows from the Release of Acquired Water on Non-CVP Controlled Streams

Tuolumne River Below La Grange Dam. Releases of acquired water would result in increases in average monthly flows in all months of all years, with the largest increases occurring in February through June. In general, average monthly flows would meet Draft AFRP Plan target flows in below normal, dry, and critical years. Average monthly flows would meet the target flows in July through April in the wet and above normal years.

Merced River Below Crocker Huffman Diversion. Releases of acquired water result in increases in average monthly flows in all months of all years, with the largest increases occurring in February through June. In general, average monthly flows would meet Draft AFRP Plan target flows in below normal, dry, and critical years. Average monthly flows would meet the target flows in July through April in the wet and above normal years.

Calaveras River at New Hogan Dam. The Draft AFRP Plan specifies target flows on the Calaveras River primarily between New Hogan Dam and Belota. Because diversions on the Calaveras River are below the AFRP flow requirement point, acquisition of water on the Calaveras River does not increase flows in the river, but would modify releases to a pattern more beneficial to instream fisheries. Since the Draft AFRP Plan stressed the importance of late winter and early spring flows, an emphasis was placed on flows in those times of the year. Also, higher releases for M&I purposes provide flows in the upper reaches of the Calaveras River in the summer and fall months. As a result of acquisition and rescheduling of releases, flows would increase in the winter and early spring months and would decrease in the summer and fall months inundations for salmon and steelhead

Mokelumne River at Woodbridge. Monthly flow requirements on the Mokelumne include the AFRP Plan flow recommendations to incorporate the 1-day, 6-day, and 7-day ramping requirements. Releases of acquired water would result in increased flows in nearly all months of the year, with the greatest increases in March, April and May.

Yuba River at Marysville. The Draft AFRP targets are met on the average in all water year types. The releases from New Bullards Bar Reservoir and down stream diversions are re-operated primarily in the below normal, dry, and critical year types to meet Draft AFRP Plan flow targets. The releases of acquired water result in increased flows in the spring, summer and fall months.

Delta Outflow

In Alternative 4, the primary change is surface water acquisition for Draft AFRP Plan target flows. The acquired water cannot be exported out of the Delta for southern deliveries, so the average annual increase in Delta outflow is 860,000 acre-feet. These flows increases mainly occur in the spring months.

ALTERNATIVE 5

Alternative 5 includes acquisition of water on Central Valley streams tributary to the Delta in an attempt to meet the Draft AFRP Working Paper goals for chinook salmon, steelhead trout, shad, sturgeon, striped bass, and other Delta species. Not all Draft AFRP Working Paper target flows are achieved due to limited water supply, operating requirements under the Biological Opinion for Winter-Run Chinook Salmon, and the operational limitations of the physical and hydrologic systems. The priority for use of acquired water is the upstream Draft AFRP Working Paper target flows. Reservoir releases are made for the target Delta outflows as available.

Water Acquisitions for Draft AFRP Target Flows and Delta Outflow

Water would be acquired in Alternative 5 to be released in a manner to help meet Draft AFRP Working Paper target flows and Delta outflow. It is assumed in Alternative 5 that the sources of acquired water would include all agricultural users of surface water derived from streams that are tributary to the Delta, all urban water supplies that could be provided by local sources (except groundwater), future development rights from urban water users in the Central Valley, and up to 25 percent conservation of these uses. In accordance with Draft AFRP Working Paper, a total of 1,200 cfs would be pumped through Tracy and Banks pumping plants for public health and safety purposes.

Impacts to CVP Operations and Deliveries

Clair Engle Lake Storage. Clair Engle Lake storage is similar to results in the Alternative 1 simulation.

Exports from the Trinity River Basin. Exports from the Trinity River Basin are similar to those in the Alternative 1 simulation.

Clear Creek Flows. Unlike Alternative 1, Draft AFRP Working Paper target flows are met in all years.

Shasta Lake Storage. Reservoir storages in Alternative 5 are equal to or greater than those in the No-Action Alternative because in dry and critical dry years, water acquisition reduces reservoir releases for Delta water quality.

Sacramento River Below Keswick Dam Flows. As discussed in Alternative 1, reservoir releases are shifted, to the extent possible, from the spring and summer months to the fall and winter months. The October through April Keswick target flows are based on October 1 storage in Shasta Lake and are therefore achieved in 100 percent of the months. As stated in Alternative 1, high reservoir releases during the spring and summer are required to meet winter-run chinook salmon temperature control requirements.

Sacramento River Below Grimes Flows. The Draft AFRP Working Paper target flows are met on the average, in all but the above normal year type. With few exceptions, Alternative 5 average monthly flows are greater than those of the No-Action This increase is due to water acquisition in the Sacramento River Basin. Instead of being diverted above Grimes, this water continues downstream.

During the February through May period when Draft AFRP Working Paper shad and sturgeon target flows are specified for wet and above normal years, target flows are achieved in 60 percent and 50 percent of the months, respectively. During April and May when target flows are specified for below normal, dry, and critically dry years, target flows are achieved in 20 percent, 50 percent, and 90 percent of the months, respectively.

Folsom Lake Storage. As discussed in the (b)(2) water management, the increase in reservoir storage is primarily the result of the end-of-year storage goal in Folsom Lake. End-of-

year reservoir storage increases by an average of 90,000 acre-feet in comparison to the No-Action Alternative. The reservoir carryover storage target of 610,000 acre-feet is met in 60 percent of the years.

American River Below Nimbus Dam Flows. As discussed in Alternative 1, reservoir releases are shifted from the spring and summer months to the fall and winter months, in accordance with the prioritized target flows. The Draft AFRP Working Paper target flows during the October through February period are achieved in 100 percent of the wet, above normal, and below normal years. For the same period, target flows are met in 90 percent of the dry years and 50 percent of critically dry years. Spring pulse targets are met in 10 percent of wet years.

New Melones Storage. Most end-of-year storages and end-of-month storages would be lower in Alternative 5 than in the No-Action Alternative. The lower storages are due to the increase in releases for Draft AFRP Working Paper target flows in on both the Stanislaus and San Joaquin Rivers.

Flows in the Stanislaus River Below Goodwin Dam. The use of acquired water in Alternative 5 would result in large flow increases over the No-Action Alternative, particularly during April through June. Average monthly flows would meet the Draft AFRP Working Paper target flows in all months of all year types. In April through June of all year types, average monthly flows would exceed the instream requirements due to additional releases of acquired water to help meet target flows on the San Joaquin River at Vernalis. Decreases in flows during the summer and fall months would result from lower releases for Vernalis water quality. Smaller releases would be necessary to maintain water quality conditions at Vernalis because the release of acquired water on the Tuolumne and Merced rivers would provide additional flows in the San Joaquin River, and thereby improve the water quality conditions at Vernalis.

San Joaquin River Water Quality at Vernalis. Water quality conditions at Vernalis would be improved as compared to the No-Action Alternative and would meet the standards in nearly all months of the simulation period. The improved water quality conditions would result from the release of acquired water on the Stanislaus, Tuolumne, Merced, and San Joaquin rivers in all months of the year.

Millerton Lake Storage. All CVP water would be acquired from water users on the Friant-Kern and Madera canals and released to the San Joaquin River to help meet flow objectives at Stevinson and Vernalis. However, the relatively small storage capacity of Millerton Lake limits the ability to store and re-operate inflows to meet the Draft AFRP Working Paper target flows. For this reason, storage in Millerton Lake would be kept at or near flood control levels to maximize the water available for releases during months with target flow requirements. In the Alternative 5 simulation, the storage in Millerton Lake would often be higher than in the No-Action Alternative, and would frequently be at or near flood control levels.

Flows in the San Joaquin River at Stevinson. The primary increases in flow would occur in April through June, as a result of releases of acquired water from Millerton Lake to help meet Draft AFRP Working Paper target flows on the San Joaquin River at Stevenson and at Vernalis. The additional releases for Vernalis target flows would be made in the below normal, dry, and critical years, primarily in the February through June period. Flow increases in the other times of

the year, from July through January, would result primarily from to flood control releases from Millerton Lake. Target flows would be met in approximately 40 percent of the months.

Flows in the San Joaquin River at Vernalis. On an average monthly basis, flows on the San Joaquin River at Vernalis would increase in nearly all months of all year types as compared to the No-Action Alternative, due to releases of acquired water the Stanislaus, Tuolumne, Merced, and San Joaquin rivers. Because the emphasis for use of acquired water on these rivers are in the April through June period, the resulting flows at Vernalis show the greatest increase in those same months. In general, average monthly flows at Vernalis meet the Draft AFRP Plan target flows in almost all months of the year in most year types. Flows on the San Joaquin River at Vernalis would meet the Draft AFRP Working Paper target flows in almost 90 percent of the months.

Exports Through Tracy Pumping Plant. In accordance with Draft AFRP Working Paper, a total of 1,200 cfs would be pumped through Tracy and Banks pumping plants for public health and safety purposes.

CVP San Luis Storage. In Alternative 5, the CVP portion of San Luis Reservoir is used to regulate flows for the delivery of refuge water supplies as well as the public health and safety water.

Deliveries. In Alternative 5, all agricultural surface water diversions are acquired from water service contractors. M&I surface water diversions are limited to the projected 1995 level of development with an assumed level of conservation of 25 percent. No further shortage criteria are applied. Refuges receive full Level 4 water supplies in all years. In accordance with Draft AFRP Working Paper, a total of 1,200 cfs is pumped through Tracy and Banks pumping plants for public health and safety purposes.

Impacts to SWP Operations and Deliveries

Lake Oroville Storage. Storages are higher in Alternative 5 than in the No-Action Alternative as a result of re-operation of acquired water for Draft AFRP Working Paper target flows on the Feather River and Delta outflows.

Feather River Below Gridley Flows. In comparison to the No-Action Alternative, reservoir releases in Alternative 5 increase in the spring months to meet pulse flow requirements. These increases are due to water acquisition as well as flow shifts from summer months to spring months. As discussed above, the spring pulse flow requirements are met in at least 70 percent of the months of all year types.

Feather River Below Nicolaus Flows. In comparison to the No-Action Alternative, reservoir releases increase in the spring months to meet pulse flow requirements. In addition, inflows from the Yuba River also increase in the spring as a result of Draft AFRP Working Paper target flows on the river. As discussed above, the spring pulse flow requirements are met in at least 90 percent of the months of all year types.

Exports through Banks Pumping Plant. In accordance with Draft AFRP Working Paper, a total of 1,200 cfs would be pumped through Tracy and Banks pumping plants for public health and safety purposes.

SWP San Luis Storage. In Alternative 5, the SWP portion of San Luis Reservoir is used to regulate flows for the delivery of refuge water supplies as well as the public health and safety water.

Resulting Streamflows from the Release of Acquired Water on Non-CVP Controlled Streams

Tuolumne River Below La Grange Dam. Releases of acquired water would result in increases in average monthly flows in all months of all years, with the largest increases occurring in February through June. In general, average monthly flows would meet Draft AFRP Plan target flows in below normal, dry, and critical years. Average monthly flows would meet the target flows in July through April in the wet and above normal years.

Merced River Below Crocker Huffman Diversion. Releases of acquired water would result in increases in average monthly flows in all months of all years, with the largest increases occurring in February through June. In general, average monthly flows would meet Draft AFRP Plan target flows in below normal, dry, and critical years. Average monthly flows would meet the target flows in July through April in the wet and above normal years.

Calaveras River at New Hogan Dam. The Draft AFRP Plan specifies target flows on the Calaveras River primarily between New Hogan Dam and Belota. Because diversions on the Calaveras River are below the AFRP flow requirement point, the use of acquired water on the Calaveras River would not increase flows in the river, but would modify releases to a pattern more beneficial to instream fisheries. Also, higher releases for M&I purposes would provide flows in the upper reaches of the Calaveras River in the summer and fall months. As a result of acquisition and rescheduling of releases, flows would increase in the winter and early spring months and decrease in the summer and fall months.

Mokelumne River at Woodbridge. Releases of acquired water would result in increased flows in nearly all months of the year, with the greatest increases in March, April and May.

Cosumnes River. Although there are no Draft AFRP Working Paper target flows prescribed for the Cosumnes River, flows on this river can contribute to Delta Outflow target flows. Therefore, surface water acquired on the Cosumnes River would be released to help meet Draft AFRP Working Paper Delta Outflow targets.

Yuba River at Marysville. The Draft AFRP targets are met on the average in all water year types. As compared to the No-Action Alternative, average spring flows increase by 1,900 to 5,600 cfs in all year types to meet the spring pulse target flows of the Draft AFRP Working Paper. Average flows also increase in the winter months of all year types by as much as 3,900 cfs. Over the entire simulation, the pulse target flows are achieved in 60 percent of the months in wet year, in 100 percent of the months in above normal, below normal, and dry years, and in 90 percent of the months in critically dry years.

Delta Outflow

The Draft AFRP flow targets are met fairly well in all but the wet year types, where a requirement of about 100,000 cfs is in effect for the months of January through May. As compared to the No-Action Alternative, average monthly flows increase by as much as 17,000 cfs in spring months of critically dry years and 47,000 cfs in spring months of wet years. The increases are due to water acquisitions on CVP streams tributary to the Delta for Draft AFRP Working Paper target flows. This water is required to provide additional Delta outflow and cannot be exported for delivery purposes. Over the entire simulation, target flows are achieved in 60 percent of the months.

GROUNDWATER

In this section the effects of the No-Acton Alternative, and Alternatives 1 through 5 (the main alternatives on groundwater conditions in the study area) are discussed. This includes a discussion by region of the quantitative analysis conducted for the Central Valley. The Sacramento River, San Joaquin River, and Tulare Lake Regions were developed based on grouping together areas with similar hydrologic features. In certain alternatives, specific areas within a particular region responded to a particular action. For this reason distinctions are made between the west and east areas of the Sacramento River Region, and the north and south areas of the Tulare Lake Region to aid in identifying the impacts associated with these actions.

Impacts considered include groundwater overdraft, land subsidence, degradation of groundwater quality and agricultural drainage, and waterlogging associated with seepage. The simulated land subsidence (resulting from groundwater level declines) for the alternative are compared to the No-Action Alternative. Simulated land subsidence were generated with the CVGSM Land Subsidence simulation model. For this programmatic level of study, the differences in land subsidence (reported at the end of the simulation period) between alternatives and the No-Action Alternative are reported regionally.

To analyze impacts on the groundwater in the valley aquifers, the Central Valley regional aquifer system was simulated using CVGSM (Central Valley Ground-Surface Water Model). The CVGSM provides water budgets, groundwater levels, groundwater gradients and land subsidence, all of which are used to compare alternatives. Groundwater impacts associated with the Alternatives are inferred from these results.

NO-ACTION ALTERNATIVE

Groundwater impacts under the No-Action Alternative are described below by region. Subsequent discussions of impacts associated with Alternatives 1 through 5 are presented as comparisons to these results.

Sacramento River Region

Annual simulated groundwater pumping in the Sacramento River Region West averages 2,038,000 acre-feet per year with groundwater supplies varying from year to year in response to

changes in water availability and demand. Annual simulated groundwater recharge (total) averages 2,034,000 acre-feet per year. Under the conditions of the No-Action Alternative, deep percolation of rainfall and applied irrigation water, on a regional basis, are responsible for more than 80 percent of the average annual recharge in this area.

Annual simulated groundwater pumping in the Sacramento River Region East averages 1,785,000 acre-feet per year with groundwater supplies varying slightly from year to year in response to changes in water availability and demand. Annual simulated groundwater recharge (total) averages 1,725,000 acre-feet per year.

In general, simulated groundwater levels in the Sacramento River Region are lowest along the valley axis and gradually rise towards the valley rim. Cones of depression occur in southern Placer and Yolo Counties, and in eastern Sacramento County. On a regional basis the hydraulic connection between streams and underlying groundwater tables is generally maintained.

Land subsidence (induced by groundwater level declines) is known to occur in the southwestern part of the Sacramento Valley basin, or within the boundaries of CVGSM subregion 6 and the southeastern tip of subregion 3. Under the No-Action Alternative, with groundwater levels declining in this area, land subsidence simulations indicate subsidence rates similar to historic conditions.

Groundwater quality would likely be degraded due to the induced migration of groundwater, high in total dissolved solids (TDS), known to exist south of the Sutter Buttes and southern Yolo county, towards depressed groundwater levels to the south and east of this area. Agricultural subsurface drainage problems in the Sacramento River Region under the No-Action Alternative would not be altered as a result of prevailing groundwater conditions, and are expected to be similar to recent historic conditions. Seepage-induced waterlogging problems along reaches of the Sacramento River are also expected to be similar to recent historic conditions.

San Joaquin River Region

Annual simulated groundwater pumping in the San Joaquin River Region averages 1,875,000 acre-feet per year. The maximum pumping is more than 70 percent above average, indicative of the areas less abundant and more variable surface water supplies in comparison to the Sacramento River Region. The annual groundwater recharge in the San Joaquin River Region averages 1,849,000 acre-feet per year.

Simulated groundwater levels on the east side of the San Joaquin River Region follow a gradient consistent with hydrographic features associated with the San Joaquin River major tributaries. Along the west side groundwater levels vary gradually over much of the region. Groundwater levels in the extreme northern end decline towards the cone of depression in eastern San Joaquin County. A decline of groundwater levels also exits in the southeastern portion of the region in the direction of a cone of depression occurring in Fresno County, south of the San Joaquin River Region. On a regional basis under the No-Action Alternative, the extent of hydraulic connection between streams and underlying groundwater tables is generally maintained.

Land subsidence (induced by groundwater level declines) is known to occur in the southwestern part of the San Joaquin River Region. Under the No-Action Alternative, land subsidence simulations indicate subsidence rates similar to historic conditions.

In areas where cones of depression exist, the migration of poor groundwater quality from adjoining areas may occur due to the steep groundwater gradient. In addition, upwelling of groundwater from below the base of normal pumping may also occur. With the exception of these conditions, on a regional basis, groundwater quality conditions under the No-Action Alternative for the San Joaquin River Region are similar to recent historic conditions. Due to the lower groundwater levels, agricultural subsurface drainage problems and seepage-induced waterlogging under the No-Action Alternative, known to exist along the west side of the San Joaquin River Region, are expected to be less severe than recent historic conditions.

Tulare Lake Region

The annual simulated groundwater pumping in the Tulare Lake Region North averages 4,043,000 acre-feet per year, ranging from approximately 2,200,000 acre-feet per year to 6,400,000 acre-feet per year. There are 4 years with pumping greater than 6,000,000 acre-feet per year and 16 more years with pumping above 5,000,000 acre-feet per year. This area of the Tulare Lake Region is dependent upon imported surface water supplies, and in some subregions there are no local surface water supplies. As these imported supplies fluctuate groundwater pumping is relied upon to make up unmet water demands. The annual simulated groundwater recharge (total) in the Tulare Lake Region averages 3,799,000 acre-feet per year.

Annual simulated groundwater pumping in the Tulare Lake Region South averages 1,411,000 acre-feet per year, ranging from approximately 700,000 acre-feet per year to 2,500,000 acre-feet per year. This area depends on numerous surface water supplies, including local supplies and imported supplies delivered by the CVP and SWP. Similar to other areas dependent upon imported supplies, fluctuations in annual groundwater pumping are frequent. The annual simulated groundwater recharge (total) in the Tulare Lake Region (South) averages 1,529,000 acre-feet per year.

In the northern half of the Tulare Lake Region, in the Fresno and Kings counties, groundwater levels decline from the valley rim towards a cone of depression southwest of the city of Fresno. In the southern half of the Tulare Lake Regions groundwater levels generally decline from the southeastern portion of the region, near Bakersfield, towards the cone of depression. On a regional basis under the No-Action Alternative streams along the east side are losing streams.

Land subsidence (induced by groundwater level declines) is known to occur in the area along the west side of the Tulare Lake Region as well as the southwestern portion of Tulare County and the southern end of Kern County. Under the No-Action Alternative, land subsidence simulations indicate subsidence rates similar to historic conditions.

Southwest of Fresno, where the cone of depression exists, the migration of poor groundwater quality from adjoining areas may occur due to the steep groundwater gradient. In addition, upwelling of groundwater from below the base of normal pumping may also occur. With the exception of these conditions, on a regional basis groundwater quality under the No-Action

Alternative for the Tulare Lake Region would be similar to recent historic conditions. Due to the lowered groundwater levels along the west side, agricultural subsurface drainage problems and seepage-induced waterlogging under the No-Action Alternative, are expected to be less severe than recent historical conditions.

ALTERNATIVE 1

Sacramento River Region

For average annual groundwater conditions for the Sacramento River Region (West), annual simulated groundwater pumping averages 2,076,000 acre-feet per year, 38,000 acre-feet per year more than under the No-Action Alternative. This average increase in pumping relative to the No-Action Alternative is a direct response to reductions in CVP deliveries to this area primarily occurring in years of dry or critically dry hydrologic conditions. The annual simulated groundwater recharge (total) in the Sacramento River Region (West) averages 2,066,000 acre-feet per year under Alternative 1, or 32,000 acre-feet per year more than under the No-Action Alternative. Relative to the No-Action Alternative, recharge increased due to a 1 percent increase in deep percolation (caused by increased refuge deliveries to the area), and a 5 percent increase in stream losses (caused by a decline in groundwater levels).

For average annual groundwater conditions for the Sacramento River Region (East) under Alternative 1, annual simulated groundwater pumping averages 1,817,000 acre-feet per year, or 32,000 acre-feet per year more than under the No-Action Alternative. This increase in pumping relative to the No-Action Alternative is a direct response to reductions in CVP deliveries to this area. The annual simulated groundwater recharge (total) in the Sacramento River Region (East) averages 1,753,000 acre-feet per year under Alternative 1, or 28,000 acre-feet per year more than under the No-Action Alternative. Relative to the No-Action Alternative, recharge increased due to a 1 percent increase in deep percolation (caused by increased refuge deliveries to the area), and a 3 percent increase in stream losses (caused by a decline in groundwater levels).

From a regional perspective, simulated groundwater levels under Alternative 1 are similar to the No-Action Alternative. In several specific areas along the west side, such as eastern Glenn County and northeastern Yolo County, groundwater levels are approximately 10 feet lower in comparison to the No-Action Alternative. The hydraulic connection between streams and underlying groundwater tables is also similar to the No-Action Alternative.

Under Alternative 1, with simulated groundwater levels declining very little in this region, no additional land subsidence in comparison to the No-Action Alternative would be induced.

Under Alternative 1, with simulated groundwater levels declining very little in this region, no substantial increase in groundwater quality degradation, or agricultural subsurface drainage problems would be expected. No change in seepage-induced waterlogging problems on farmlands adjacent to the Sacramento River are expected to result from streamflow and groundwater conditions.

San Joaquin River Region

For average annual groundwater conditions for the San Joaquin River Region under Alternative 1, annual simulated groundwater pumping averages 1,915,000 acre-feet per year, or 40,000 acre-feet per year more than under the No-Action Alternative. The variations in groundwater pumping is very similar to the No-Action Alternative. The annual simulated groundwater recharge (total) averages 1,883,000 acre-feet per year, 35,000 acre-feet per year more than under the No-Action Alternative. The recharge increased relative to the No-Action Alternative due to a slight increase in deep percolation (caused by increased refuge deliveries to the area) and seepage from canals, and a 7 percent increase in stream losses (caused by a decline in groundwater levels).

From a regional perspective, simulated groundwater levels in the north half of the region are similar to the No-Action Alternative. In the southwestern corner (the Delta Mendota Canal service area) groundwater levels are lower by approximately 10 to 20 feet. The hydraulic connection between streams and underlying groundwater tables is also similar to the No-Action Alternative.

Over the 69-year simulation, land subsidence ranges between 1 and 5 feet would occur under Alternative 1 in the southwestern portion of the region. This is a result of the water level declines mentioned above. The area of land subsidence surrounds major conveyance facilities including the Delta Mendota Canal and the California Aqueduct.

Under Alternative 1, with groundwater levels declining primarily along the westside of the San Joaquin River Region, it is expected that regional groundwater quality in the San Joaquin River Region would not change in comparison to the No-Action Alternative. It is expected that agricultural subsurface drainage problems in the San Joaquin River Region would not change in comparison to the No-Action Alternative. Seepage-induced waterlogging problems on farmlands along the lower reaches of the San Joaquin River and its tributaries are not expected to differ under Alternative 1 from those under the No-Action Alternative.

Tulare Lake Region

For average annual groundwater conditions for the Tulare Lake Region (North) under Alternative 1, annual simulated groundwater pumping averages 4,129,000 acre-feet per year, or 86,000 acre-feet per year more than under the No-Action Alternative. Groundwater pumping for Alternative 1 was the same or larger than No-Action pumping throughout the simulation period. This increase in pumping is a direct response to reductions in CVP deliveries to this area. The annual simulated groundwater recharge (total) in the Tulare Lake Region (North) averages 3,833,000 acre-feet per year, or 34,000 acre-feet per year more than under the No-Action Alternative. The recharge increased relative to the No-Action Alternative due to a 5 percent increase in seepage from canals, and a 4 percent increase in subsurface flow from adjacent areas (caused by a decline in groundwater levels).

For average annual groundwater conditions for the Tulare Lake Region (South) under Alternative 1, annual simulated groundwater pumping averages 1,380,000 acre-feet per year, or 31,000 acre-feet per year less than under the No-Action Alternative. This decrease in

groundwater pumping is a result of additional SWP supplies becoming available as part of the Alternative 1 surface water analysis (see previous discussion under the Water Facilities and Supplies section). The Alternative 1 annual simulated groundwater recharge (total) in the Tulare Lake Region (South) averages 1,513,000 acre-feet per year, or 16,000 acre-feet per year less than under the No-Action Alternative. As a result of these pumping and recharge conditions, changes in groundwater storage conditions are very minor in comparison to the No-Action Alternative.

Simulated groundwater levels for Alternative 1 for the end of the simulation period are lower in comparison to the No-Action Alternative along the west side of the region, with differences exceeding 80 feet. This is primarily in response to a reduction in available surface water supplies resulting in greater groundwater withdrawals. There is little differences in groundwater levels along the east side of the Tulare Lake Region. Stream-groundwater interaction is similar under Alternative 1 in comparison to the No-Action Alternative.

Additional overdraft observed in Alternative 1 in comparison to the No-Action Alternative indicates that land subsidence would occur along the west side of the Tulare Lake Region (North). The range of differences along the west side is between 10 and 15 feet. The range in differences decreases to 1 to 5 feet towards the axis of the Central Valley. The area of land subsidence surrounds major conveyance facilities including the Delta Mendota Canal and the California Aqueduct.

The presence of lower simulated groundwater levels along the west side of the Tulare Lake Region in relation to No-Action Alternative simulated groundwater levels would cause stronger migration of poor-quality groundwater into the region. T.S. concentrations ranging between 501 mg/l and 1,500 mg/l, and in some cases higher than 1,500 mg/l would possibly contaminate groundwater of better quality in the western Fresno County area. Potential upwelling of saline water associated with this drop in groundwater head would be more likely under Alternative 1 conditions than No-Action. With groundwater levels declining primarily along the westside of the Tulare Lake Region, it is expected that agricultural subsurface drainage problems associated with the westside of the San Joaquin River Region would not change in comparison to the No-Action Alternative. There are no regional seepage-induced waterlogging problems associated with high groundwater tables in the Tulare Lake Region and none of the options associated with Alternative 1 would initiate any seepage-induced waterlogging problems in comparison to the No-Action Alternative.

ALTERNATIVE 2

Sacramento River Region

For average annual groundwater conditions for the Sacramento River Region (West) under Alternative 2, groundwater conditions are similar to Alternative 1. See the Alternative 1 groundwater impacts assessment for the Sacramento River Region.

For average annual groundwater conditions for the Sacramento River Region (East) under Alternative 2, Alternative 2 groundwater conditions are similar to Alternative 1. Average annual simulated groundwater pumping in Alternative 2 would be slightly higher than Alternative 1.

This is caused by economic incentive to replace acreage retired in the San Joaquin River Region due to water acquisitions.

From a regional perspective, simulated groundwater levels under Alternative 2 are similar to the No-Action Alternative. Groundwater levels are lower by approximately 10 feet in the Sacramento County area. The hydraulic connection between streams and underlying groundwater tables is also similar to the No-Action Alternative.

Under Alternative 2, with simulated groundwater levels declining very little in this region, no additional land subsidence in comparison to the No-Action Alternative would be induced.

Under Alternative 2, with simulated groundwater levels declining very little in this region, it is expected that groundwater quality and agricultural subsurface drainage problems in the Sacramento River Region would not change in comparison to the No-Action Alternative. Sacramento River summer flows under Alternative 2 are similar to Alternative 1, and like Alternative 1, no change in seepage-induced waterlogging problems on farmlands adjacent to the Sacramento River are expected for streamflow and groundwater conditions under Alternative 2.

San Joaquin River Region

For average annual groundwater conditions for the San Joaquin River Region under Alternative 2, annual simulated groundwater pumping averages 1,928,000 acre-feet per year, or 53,000 acre-feet per year more than under the No-Action Alternative. Average annual groundwater pumping in Alternative 2 is slightly higher than Alternative 1. This is caused by economic incentive to replace acreage retired in the San Joaquin River Region due to water acquisitions. The annual simulated groundwater recharge (total) in the San Joaquin River Region averages 1,894,000 acre-feet per year, or 45,000 acre-feet per year more than under the No-Action Alternative.

On a regional basis, simulated groundwater levels under Alternative 2 are similar to the No-Action Alternative. In the southwestern corner (the Delta Mendota Canal service area) groundwater levels are lower by approximately 10 feet. On a regional basis under Alternative 2 the hydraulic connection between streams and underlying groundwater tables is similar to the No-Action Alternative.

Land subsidence impacts for Alternative 2 are similar to Alternative 1. See the impacts assessment for Alternative 1.

Elevated levels of nitrates in groundwater in eastern Merced County may migrate towards areas of better water quality as a result of lower groundwater levels relative to No-Action Alternative. Relative to the No-Action Alternative, other groundwater quality parameters of concern would likely not be affected by Alternative 2 groundwater conditions. On a regional basis agricultural subsurface drainage problems would be less severe relative to the No-Action Alternative as a result of lower simulated groundwater levels relative to the No-Action Alternative. Seepage-induced waterlogging problems on farmlands along the lower reaches of the San Joaquin River and its tributaries are expected to be less severe under Alternative 2 from those under the No-Action Alternative as a result of the lower simulated groundwater levels under Alternative 2.

Tulare Lake Region

Under Alternative 2, simulated groundwater conditions and land subsidence associated with the north and south subareas of the Tulare Lake Region are similar to Alternative 1. See the Alternative 1 impact assessment.

Under Alternative 2, groundwater quality and agricultural subsurface drainage associated with the north and south subareas of the Tulare Lake Region are similar to Alternative 1. See the Alternative 1 impact assessment. There are no regional seepage-induced waterlogging problems associated with high groundwater tables in the Tulare Lake Region and none of the options associated with Alternative 2 would initiate any seepage-induced waterlogging problems in comparison to the No-Action Alternative.

ALTERNATIVE 3

Sacramento River Region

For average annual groundwater conditions for the Sacramento River Region (West) under Alternative 3, groundwater conditions are similar to Alternative 1. See the Alternative 1 impacts assessment for the Sacramento River Region.

For average annual groundwater conditions for the Sacramento River Region (East) under Alternative 3, groundwater conditions are similar to Alternative 2. See the Alternative 2 groundwater impacts assessment for the Sacramento River Region (East).

From a regional perspective, simulated groundwater levels under Alternative 3 are similar to the No-Action Alternative. Groundwater levels are lower by approximately 10 feet in the Sacramento County area. The hydraulic connection between streams and underlying groundwater tables is also similar to the No-Action Alternative.

Under Alternative 3, with simulated groundwater levels declining very little in this region, no additional land subsidence in comparison to the No-Action Alternative would be induced.

Under Alternative 3, with groundwater levels declining very little in this region, it is expected that groundwater quality and agricultural subsurface drainage problems in the Sacramento River Region would not change in comparison to the No-Action Alternative. Sacramento River summer flows under Alternative 3 are similar to Alternative 1. No change in seepage-induced waterlogging problems on farmlands adjacent to the Sacramento River are expected to result from Alternative 3 streamflow and groundwater conditions under Alternative 2 in comparison to the No-Action Alternative.

San Joaquin River Region

For average annual groundwater conditions for the San Joaquin River Region under Alternative 3, groundwater pumping averages 1,948,000 acre-feet per year, or 73,000 acre-feet per year more than under the No-Action Alternative. The annual simulated groundwater recharge (total) in the San Joaquin River Region averages 1,901,000 acre-feet per year, or 53,000 acre-feet per year

more than under the No-Action Alternative. Relative to the No-Action Alternative deep percolation declined due to a reduction in irrigation applied water and an increase in irrigation efficiency of 2 percent on average. Gains from streams increased 97 percent as a result of higher streamflows and lowered groundwater levels. Recharge from leaky canals, however, dropped by approximately 33 percent relative to the No-Action Alternative owing to large reductions in agricultural subsurface water delivery.

Under Alternative 3 regional groundwater levels are lower relative to the No-Action Alternative, but range between slightly higher than under the No-Action Alternative along the lower reach of the Merced River and the San Joaquin River to 10 to 20 feet lower in western Madera and eastern Merced Counties. Groundwater levels east of Stockton dropped 10 feet in Alternative 3 in comparison to the No-Action Alternative. On a regional basis the hydraulic connection between streams and underlying groundwater tables is similar to the No-Action Alternative, except possibly in the vicinity of the Chowchilla and Fresno Rivers where groundwater levels have declined relative to the No-Action Alternative conditions.

Land subsidence impacts for Alternative 3 are very similar to Alternative 1. See the impacts assessment for Alternative 1.

Elevated levels of nitrates in groundwater in eastern Merced County may migrate towards areas of better water quality as a result of lower groundwater levels relative to No-Action Alternative. Other groundwater quality parameters of concern would likely not be affected by Alternative 3 groundwater conditions. It is expected that agricultural subsurface drainage problems and seepage-induced waterlogging in the San Joaquin River Region would be lessened in comparison to the No-Action Alternative.

Tulare Lake Region

Under Alternative 3, simulated groundwater conditions and land subsidence associated with the north and south subareas of the Tulare Lake Region are similar to Alternative 1. See the Alternative 1 impact assessment.

Under Alternative 3, groundwater quality and agricultural subsurface drainage associated with the north and south subareas of the Tulare Lake Region are similar to Alternative 1. See the Alternative 1 impact assessment. There are no regional seepage-induced waterlogging problems associated with high groundwater tables in the Tulare Lake Region and none of the options associated with Alternative 3 would initiate any seepage-induced waterlogging problems in comparison to the No-Action Alternative.

ALTERNATIVE 4

Sacramento River Region

For average annual groundwater conditions for the Sacramento River Region (West) under Alternative 4, groundwater conditions are similar to Alternative 1, with the exception of stream losses and boundary inflows. Each of these components is affected by regional declines occurring along the east side of the valley floor.

For average annual groundwater conditions for the Sacramento River Region (East) under Alternative 4, average annual simulated groundwater pumping increases in comparison to the No-Action Alternative, and is approximately 5 percent higher on average than Alternative 1. This is caused by economic incentive to replace acreage retired due to water acquisitions. The annual simulated groundwater recharge (total) is larger on average than under the No-Action Alternative. Increased stream losses and boundary inflows are responsible for the increase in recharge.

For areas along the west side of the region groundwater levels are similar to the No-Action Alternative. Simulated groundwater levels are lower along the east side of the region due to the reduction in applied surface water and an increase in groundwater pumping. In Butte, Yuba, and Placer Counties, simulated groundwater levels decrease by an additional 10 to 20 feet from the No-Action Alternative. Maximum declines in simulated groundwater levels occur north and south of Sacramento, where additional declines of more than 50 feet relative to the No-Action Alternative occur.

Under Alternative 4 areas outside of the water acquisition zones maintain similar stream-aquifer interactions as expected under the No-Action Alternative. Streams in the vicinity of water acquisition areas in the northern portion of the Sacramento River Region (East) which exhibit net gains from groundwater under the No-Action Alternative, exhibit net discharges to the underlying groundwater basins as a result of the simulated groundwater level declines occurring in Alternative 4. Streams associated with water acquisition areas in the southern portion of the Sacramento River Region (East) would experience an increase in the stream loss rate to underlying groundwater basins under Alternative 4 in comparison to the expected prevailing conditions under the No-Action Alternative. In some instances, hydraulic continuity between these streams and related aquifers would be lost.

Under Alternative 4, with groundwater levels declining very little in areas where potential land subsidence due to groundwater level declines exists, no additional land subsidence in comparison to the No-Action Alternative is expected.

Declining groundwater levels relative to No-Action Alternative would induce migration of poor-quality groundwater into areas of good-quality groundwater. In the Sacramento, Sutter, and Yuba County areas, reported Boron, Nitrate, Iron, and Manganese problems could be mobilized into areas where problems with groundwater quality were not present. Theses declines in groundwater levels are expected to improve agricultural subsurface drainage problems and seepage-induced waterlogging in the Sacramento River Region.

San Joaquin River Region

Simulated groundwater conditions for the San Joaquin River Region under Alternative 4 are similar to Alternative 3, (see the impact assessment for Alternative 3).

Tulare Lake Region

Simulated groundwater conditions for the Tulare Lake Region under Alternative 4 are similar to Alternative 1, (see the impact assessment for Alternative 1).

ALTERNATIVE 5

Sacramento River Region

For average annual groundwater conditions for the Sacramento River Region (West) under Alternative 5, average annual groundwater pumping is similar to Alternative 1. Average groundwater recharge is 10,000 acre-feet lower than the No-Action Alternative, however the conditions for which Alternative 5 represents cause the recharge components to change in comparison to the No-Action Alternative. Deep percolation would be much less due to the large reduction in irrigation applied water resulting from retirement of lands associated with water acquisitions. This would cause groundwater levels to decline which would in turn induce additional stream losses. This indicates stream losses to groundwater would nearly triple in comparison with the No-Action Alternative.

Under Alternative 5 average annual groundwater pumping for the Sacramento River Region (East) is similar to the No-Action Alternative. Average groundwater recharge is similar to the No-Action Alternative, however the conditions for which Alternative 5 represents cause the recharge components to change in comparison to the No-Action Alternative. The shifts are similar to those discussed above for the west side of the Sacramento River Region. Deep percolation drops nearly in half compared to the No-Action Alternative, a result of retired lands associated with water acquisitions. Stream losses would increase due to lower groundwater tables in comparison to the No-Action Alternative.

For areas along the west side of the region simulated groundwater levels decline up to 50 feet in Glenn County and up to 75 feet in western Yolo County in comparison to the No-Action Alternative. Along the east side of the valley floor groundwater levels decline up to 125 feet north of the Sutter Buttes, and up to 100 feet east and south of the Sutter Buttes, in southwestern Yuba County and the boundary between Placer and Sacramento County. Under Alternative 5 the numerous streams in the Sacramento River Region would experience an increase in the stream loss rate to underlying groundwater basins. In some instances, the hydraulic continuity between the surface and subsurface systems would severed. These simulation results indicate that this part of the Sacramento River Region basin under Alternative 5 would be placed in severe overdraft.

The areas where groundwater levels are dropping relative to the No-Action Alternative are areas known to be subjected to historical land subsidence. The declining groundwater levels may further induce land subsidence in these areas.

Under Alternative 5, groundwater elevations and movement change considerably from No-Action Alternative conditions causing migration of all water quality constituents of concern in the Sacramento River Region. However, the impact of this migration of poor-quality groundwater into areas of good quality groundwater cannot be easily assessed given the extreme changes brought on by the conditions associated with this alternative. The impacts are probably small in comparison to other impacts such as land subsidence and overdrafting of groundwater basins. The declines in simulated groundwater levels are expected to alleviate agricultural subsurface drainage problems in the Sacramento River Region in comparison to the No-Action Alternative. Implementation of Alternative 5 would result in large increases in frequency levels

at all flows in the Sacramento River. A substantial increase in the frequency and duration of seepage-induced waterlogging problems on farmlands along the Sacramento River should be anticipated under Alternative 5. It is anticipated that such lands would be candidate lands for development of conservation easements.

San Joaquin River Region

Under Alternative 5 average annual groundwater pumping is 23,000 acre-feet per year higher than the No-Action Alternative. Average groundwater recharge is 17,000 acre-feet lower than the No-Action Alternative, however the conditions for which Alternative 5 represents cause the recharge components to change in comparison to the No-Action Alternative. There is a large reduction in deep percolation in agricultural areas resulting from land retirement associated with water acquisitions, which leads to severe overdraft in those areas.

Under Alternative 5 the numerous streams in the San Joaquin River Region would experience an increase in the stream loss rate to underlying groundwater basins. In some instances, the hydraulic continuity between the surface and subsurface systems would be severed. Differences in simulated groundwater levels under Alternative 5 from the No-Action Alternative for the end of the simulation period range from 150 feet in the vicinity of the Stanislaus River at the northeast border of the study area to 100 feet in western Fresno County.

For Alternative 5, the differences on simulated land subsidence ranges between 5 and 10 feet would occur under Alternative 5 in the southwestern portion of the region. This is a result of the water level declines mentioned above. The area of land subsidence surrounds major conveyance facilities including the Delta Mendota Canal and the California Aqueduct.

Under Alternative 5, groundwater elevations and movement change considerably from No-Action Alternative conditions causing migration of all water quality constituents of concern in the San Joaquin River Region. However, the impact of this migration of poor-quality groundwater into areas of good quality groundwater cannot be easily assessed given the extreme changes brought on by the conditions associated with this alternative. The impacts are probably small in comparison to other impacts such as land subsidence and overdrafting of groundwater basins. The declining groundwater levels are expected to alleviate agricultural subsurface drainage problems and seepage-induced waterlogging in the San Joaquin River Region in comparison to the No-Action Alternative. Increases in the frequency and duration of high San Joaquin River summer flows may contribute to increased flooding problems on lands adjoining the lower reaches of the river. Costs to crop production would probably be diminished as water acquisition takes these lands out of production.

Tulare Lake Region

For average annual groundwater conditions for the Tulare Lake Region (North) under Alternative 5, average annual groundwater pumping is 4,121,000 acre-feet per year, or 78,000 acre-feet per year more than No-Action Alternative. Groundwater recharge is 3,510,000 acre-feet per year, a drop of 290,000 acre-feet per year relative to the No-Action Alternative. This is a result of reduced irrigation applied water, a primary source of recharge via deep percolation in this region. Based on these conditions groundwater storage declines at greater than twice the rate of decline

under the No-Action Alternative conditions. These simulation results indicate that this part of the Tulare basin under Alternative 5 would be placed in severe overdraft.

For average annual groundwater conditions for the Tulare Lake Region (South) under Alternative 5, average annual groundwater pumping is 1,398,000 acre-feet per year, or 13,000 acre-feet per year less than No-Action Alternative. Groundwater recharge is 1,292,000 acre-feet per year, a drop of 236,000 acre-feet per year relative to the No-Action Alternative. This is a result of reduced irrigation applied water, a primary source of recharge via deep percolation in this region. Based on these conditions groundwater storage is reduced over the course of the study period.

In general groundwater levels under Alternative 5 are declining due to the loss of recharge. The numerous streams in the Tulare Lake Region would experience an increase in the stream loss rate to underlying groundwater basins. The total net streamflow loss for Alternative 5 relative to the No-Action Alternative would be less than 5 percent of the total streamflow passing through the water acquisition areas.

The range of differences on simulated land subsidence over the 69-year simulation, under Alternative 5 would be between 1 and 5 feet in the southwestern portion of the region, 5 to 10 feet towards the center of the valley, and 15 to 20 feet along the west side and in the Tulare County area.

Under Alternative 5, groundwater elevations and movement change considerably from No-Action Alternative conditions causing migration of all water quality constituents of concern in the Tulare Lake Region. However, the impact of this migration of poor-quality groundwater into areas of good quality groundwater cannot be easily assessed given the extreme changes brought on by the conditions associated with this alternative. The impacts are probably small in comparison to other impacts such as land subsidence and overdrafting of groundwater basins. Declining groundwater levels are expected to alleviate some of the agricultural subsurface drainage problems and seepage-induced waterlogging in the Tulare Lake Region in comparison to the No-Action Alternative.

CVP POWER RESOURCES

The CVP hydroelectric facilities are part of the large multipurpose project encompassing such areas as power production, flood control, irrigation water supply, municipal and industrial water supply, fish and wildlife, water quality, wetlands maintenance, navigation, and recreation. The major driving factors in powerplant operation are the required downstream water releases, the electric system needs, and Project Use demand. The CVP power facilities include 11 hydroelectric powerplants with 38 generators, and have a total maximum generating capacity of 2,045 megawatts (MW). The CVP powerplants have produced an average of 4,800 gigawatt-hours (GWh) per year over the last 15 years.

Currently, CVP power is marketed under an agreement signed in 1967 between Reclamation and the PG&E. This agreement (Contract 2948A), provides for the integrated operation of the CVP generation with the PG&E system. CVP power is used throughout Central and Northern California, first to meet the authorized needs of the project including irrigation pumping, M&I

pumping, Fish and Wildlife and station service. Approximately 25 to 30 percent of the CVP total power generation is used to support Project Use demand. The remaining power is marketed by the Western Area Power Administration (Western) to preference customers such as federal agencies, military bases, municipalities, public utilities districts, irrigation and water districts, and state agencies. Power produced in excess of Project Use load and preference customer deliveries is delivered to the PG&E under an agreement which allows for the sale, interchange, and transmission of electrical power and energy between the federal government and PG&E. The contract expires at the end of 2004 and is not expected to be renewed, but for the purposes of this discussion, it is assumed that generation in excess of Project Use needs will continue to be marketed.

NO-ACTION ALTERNATIVE

Under the No-Action Alternative, the CVP power generation facilities are operated in a manner similar to the operations discussed under the Affected Environment. The primary differences between operations under the No-Action Alternative and Affected Environment are related to the revised Stanislaus River operations, changes to CVP power generation facilities due to operations under the Bay-Delta Plan Accord and the operation of the Shasta temperature control device which eliminates the need to bypass Shasta powerplant.

The simulated average annual generation over the period of 1922 to 1990 for the CVP as measured at the generating plants would be 5,266 GWh with the peak generation occurring during the summer period. The average monthly generation is shown in Figure III-1. The average annual Project Use energy requirement as measured at load center is 1,425 GWh. The peak Project Use energy requirement also occurs during the summer. The average monthly Project Use energy requirement is also shown in Figure III-1. With transmission losses taken into account, the average annual energy available for sale under the No-Action Alternative would be 3,511 GWh.

ALTERNATIVE 1

Average power generation under this alternative is reduced at Trinity, Carr, and Spring Creek powerplants due to increases in minimum instream flows in the Trinity River. Power generation also is changed at Folsom, Nimbus, and New Melones powerplants due to changes in reservoir operations primarily due to the (b)(2) Water Methodology. The average annual generation under Alternative 1 would be 4,975 GWh, or a reduction of approximately 6 percent from the No-Action Alternative. As shown in Figure III-1, the majority of this reduction in generation occurs in the summer period of June through September. These changes are primarily related to the increased releases in the spring months and reduced releases in the summer months under the (b)(2) Water Methodology.

Project Use requirements also would be changed under Alternative 1 as compared to the No-Action Alternative due to changes in Delta export patterns and the overall reduction in delivery of CVP water which would reduce project pumping requirements. The estimated annual Project Use energy requirement would be 1,278 GWh, or a decrease of approximately 10 percent. As shown in Figure III-1, these decreases would generally occur in all months with the largest decreases occurring in the summer period.

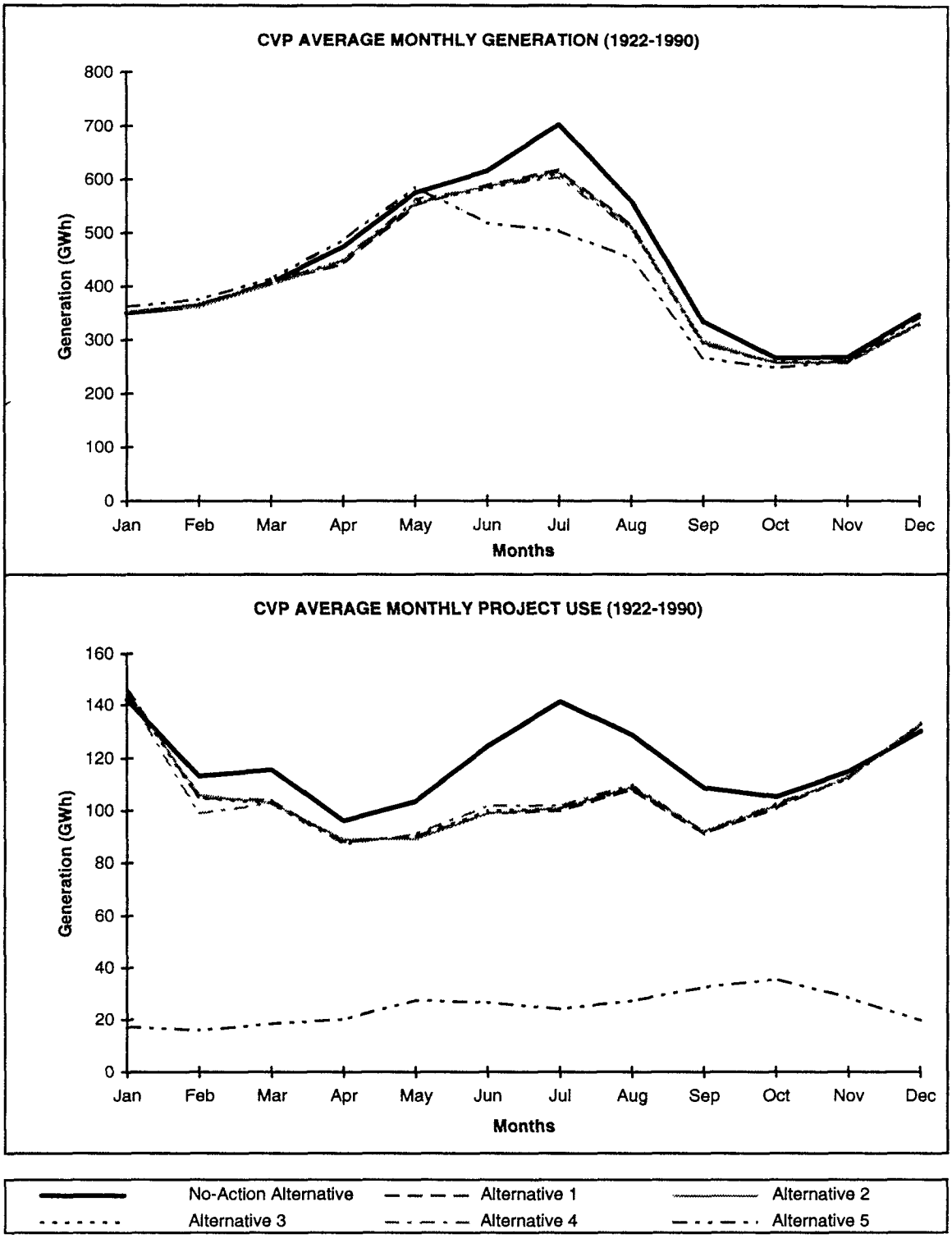

FIGURE III-1
COMPARISON OF SIMULATED CVP AVERAGE MONTHLY GENERATION AND PROJECT USE

C—081112

C-081112

The combination of reduction of annual generation and Project Use requirements would result in approximately 3,400 GWh of energy available for sale, or an annual reduction of approximately 3 percent compared to the No-Action Alternative. Power production at non-CVP facilities would generally not be impacted under this alternative.

ALTERNATIVE 2

As shown in Figure III-1, changes in CVP power generation and Project Use under this alternative are similar to those discussed under Alternative 1, which result in essentially the same amount of energy available for sale under this alternative.

Power production at non-CVP facilities would generally not be affected. However, power production at Battle Creek and the Tuolumne and Merced rivers would be reduced.

ALTERNATIVE 3

As shown in Figure III-1, changes in CVP power generation and Project Use under this alternative are similar to those discussed under Alternative 1, which result in essentially the same amount of energy available for sale under this alternative.

Power production at non-CVP facilities would generally not be affected. However, power production at Battle Creek and the Tuolumne and Merced rivers would be reduced.

ALTERNATIVE 4

As shown in Figure III-1, changes in CVP power generation and Project Use under this alternative are similar to those discussed under Alternative 1, which result in essentially the same amount of energy available for sale under this alternative.

Power production at non-CVP facilities would generally not be affected. However, power production at Battle Creek and the Yuba, Tuolumne, and Merced rivers would be reduced.

ALTERNATIVE 5

This alternative would have the largest decrease in average annual generation. The average annual generation would decrease by approximately 8 percent. As shown in Figure III-1, the primary reduction in this generation would occur in the June through September period. This alternative would also result in a shift in the month that the peak monthly generation would occur. Under all other alternatives, the peak average monthly generation occurs in July, while under Alternative 5, the peak average monthly generation occurs in May.

Project Use changes significantly under this alternative. Since exports from the Delta are limited to Public Health and Safety needs, the average annual Project Use energy requirement under this alternative is 294 GWh, a decrease of 79 percent from the No-Action Alternative. As shown in Figure III-1, the Project Use energy requirement is essentially constant in all months.

The large decrease in Project Use energy results in an increase in the amount of energy available for sale. The average annual energy available for sale increases to approximately 4,200 GWh, or a 20 percent increase compared to the No-Action Alternative.

Power production at non-CVP hydropower powerplants on most rivers that are tributary to the Delta would be reduced.

MUNICIPAL AND INDUSTRIAL LAND USE AND DEMOGRAPHICS

NO-ACTION ALTERNATIVE

Under the No-Action Alternative projected municipal and industrial land use areas for 1990 and 2020, based on the California Department of Water Resources (DWR) projections. Municipal land use areas are projected to increase between 25 percent in the San Francisco Bay Region, and 48 percent in the Tulare Lake Region. The overall projected increase in municipal land use throughout the four regions is approximately 34 percent. The projected water supplies to municipal areas would generally be provided from surface water sources, pursuant to existing water rights, or from additional groundwater pumping. The affects of these additional water supplies on surface water and groundwater resources is incorporated to the No-Action Alternative conditions.

ALTERNATIVE 1

Under Alternative 1, deliveries of CVP water supplies to municipal users in the Central Valley and San Francisco Bay regions would be reduced. In general, the frequency that 25 percent deficiencies to municipal CVP deliveries north of the Delta would increase from approximately 15 percent of the years under the No-Action Alternative to approximately 25 percent of the years under Alternative 1. Similarly, the frequency that 25 percent deficiencies to municipal CVP deliveries south of the Delta would increase from approximately 20 percent of the years under the No-Action Alternative to approximately 45 percent of the years under Alternative 1.

It is anticipated that conservation efforts that would be implemented during years with CVP deficiencies under the No-Action Alternative would also be implemented during years of similar water contract deficiency under Alternative 1. Therefore, municipal land uses and population conditions under Alternative 1 would not change as compared to the No-Action Alternative.

Under Alternative 1, the frequency of deficiencies on SWP municipal water deliveries would be reduced, thereby increasing the frequency of full contract deliveries. However, the maximum annual delivery quantity under Alternative 1 would not increase as compared to the No-Action Alternative. Therefore, the changes in deliveries to the SWP in Alternative 1 would not result in increased growth of municipal areas, or increases in populations, as compared to the No-Action Alternative.

ALTERNATIVE 2

The deliveries of water to CVP and SWP municipal water users under Alternative 2 would be the same as those described under Alternative 1. The acquisition of water from willing sellers on the

Stanislaus, Tuolumne, and Merced rivers would be acquired from non-M&I sellers. Therefore, the total changes to municipal water supplies and affects on demographics in Alternative 2 would be the same as those described under Alternative 1.

ALTERNATIVE 3

The deliveries of water to CVP and SWP municipal water users under Alternative 3 would be the same as those described under Alternative 1. The acquisition of water from willing sellers on the Stanislaus, Tuolumne, and Merced rivers would be acquired from non-M&I sellers. Therefore, the total changes to municipal water supplies and affects on demographics in Alternative 4 would be the same as those described under Alternative 1.

ALTERNATIVE 4

The deliveries of water to CVP and SWP municipal water users under Alternative 4 would be the same as those described under Alternative 1. The acquisition of water from willing sellers on the Stanislaus, Tuolumne, and Merced rivers would be acquired from non-M&I sellers. Therefore, the total changes to municipal water supplies and affects on demographics in Alternative 4 would be the same as those described under Alternative 1.

ALTERNATIVE 5

Under Alternative 5, all basin surface water diversions that are projected to serve agriculture and projected municipal growth in the Sacramento, Delta, and San Joaquin River basins would be acquired to meet the Draft AFRP Working Paper flow requirements. It is assumed that all municipal users of CVP surface waters located in the Central Valley would willingly sell up to 25 percent of the existing amount of water used and all water amounts to be used for projected growth between 1995-2020. It is further assumed that the price of water from these sellers would include costs to implement water conservation programs to achieve long-term reduction of municipal demand equal to 25 percent of 1990 level demands.

It is possible to achieve reduction in demand through a variety of conservation measures including; reductions in outdoor use of water for landscaping purposes, and reductions in indoor use of water through replacement or conversion of conventional fixtures and appliances to high-efficiency types such as low-flow showerheads, low-volume toilets and water-saving appliances (e.g. dishwashers and washing machines). Therefore, municipal land uses would not be affected as compared to the No-Action Alternative. In addition, total population and demographics would not be impacted under Alternative 5 as compared to the No-Action Alternative. Municipal water users that import Central Valley surface water to the San Francisco Bay and South Coast regions would also willingly sell all imports under Alternative 5. The funds from water sales would pay for increased conservation measures and for desalinization water treatment plants and conveyance facilities. Therefore, population projections, and municipal land uses would not be impacted under Alternative 5 as compared to the No-Action Alternative.

AGRICULTURAL ECONOMICS AND LAND USE

Geographic areas for the assessment of agricultural impacts include three Central Valley regions and the San Felipe CVP delivery area. Agricultural economics and land use impacts are assessed primarily by comparing irrigated acres, value of production (or gross revenue), net revenue, and irrigation water use. All prices and costs are measured in real, 1992 dollars. A summary of the assessment for the San Felipe unit is included at the end of the discussion for each alternative.

NO-ACTION ALTERNATIVE

Starting from DWR's 2020 baseline land use, the water supplies estimated in the surface water and groundwater analysis were used to estimate irrigated land use. Results for the three Central Valley regions are summarized in Table III-3. Major crops in the Sacramento River Region include rice, deciduous orchards, grains, and other field crops. The San Joaquin River Region includes a wide mix of crops, with deciduous orchards, cotton, and truck crops having the largest acreage. The predominant acreage in the Tulare Lake Region are cotton, deciduous orchards, and grapes. Alfalfa hay and grains show significant acreage in all three regions.

Table III-4 summarizes the value of production, or gross revenue of crops by region and crop. The Sacramento River Region accounts for about 18 percent of Central Valley value of production. The Tulare Lake Region accounts for about 38 percent and San Joaquin River Region about 43 percent.

Fruit and vegetable crops such as truck crops, tomatoes, orchards, and vineyards account for over two thirds of the value of irrigated production valley wide. Cotton and rice also produce significant revenue. Although the direct value of other crops such as hay and grains is relatively low, they support linked sectors such as dairies, other livestock, and food processing.

Table III-5 shows estimated net revenue from production of the irrigated crops in each region. The Sacramento River Region includes about 30 percent of acreage but accounts for less than 20 percent of valley wide net income due to the crop mix, yields, and prices received. The San Joaquin and Tulare Regions each account for about 40 percent of net income

Table III-6 shows applied irrigation water by source and region. Under the No-Action Alternative average condition approximately 11.7 million acre-feet of surface water and 9.3 million acre-feet of groundwater is applied to irrigated lands, for a total of about 21 million acre-feet. Surface water application declines in a dry condition, but groundwater pumping increases. Total application increases in a dry condition because less rainfall is available and more consumptive demand must be met through irrigation. The opposite occurs in a wet condition. Table III-7 shows evapotranspiration of applied water and irrigation application efficiency. Irrigation efficiency averages 70.4 percent valley wide, ranging from 66 percent in the Sacramento Valley to 73.8 percent in the Tulare Lake Region as summarized in Table III-6.

Table III-8 summarizes irrigated acres, CVP delivery, value of production, and net income for the San Felipe Division.

TABLE III-3

IRRIGATED ACREAGE UNDER NO-ACTION ALTERNATIVE
(Thousand Acres)

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	165	160	165
Alfalfa	115	113	116
Sugar Beets	80	79	80
Other Field Crops	264	261	265
Rice	473	467	475
Truck Crops	105	105	105
Tomatoes	145	145	145
Deciduous Orchard	349	349	349
Small Grain	272	265	272
Grapes	37	37	37
Subtropical Orchard	14	14	14
Subtotal	2,019	1,995	2,023
San Joaquin River Region			
Pasture	147	145	146
Alfalfa	191	188	191
Sugar Beets	43	42	43
Other Field Crops	273	270	273
Rice	14	14	14
Truck Crops	311	311	311
Tomatoes	151	150	151
Deciduous Orchard	472	472	472
Small Grain	163	159	164
Grapes	279	279	279
Cotton	465	452	465
Subtropical Orchard	49	49	49
Subtotal	2,558	2,531	2,558
Tulare Lake Region			
Pasture	10	8	10
Alfalfa	181	172	183
Sugar Beets	19	19	19
Other Field Crops	177	170	177
Rice	0	0	0
Truck Crops	205	205	205
Tomatoes	6	6	6
Deciduous Orchard	264	264	264
Small Grain	108	102	109
Grapes	244	244	244
Cotton	646	620	649
Subtropical Orchard	150	150	150
Subtotal	2,010	1,960	2,016
Total	6,587	6,486	6,597

TABLE III-4

GROSS REVENUES IN NO-ACTION ALTERNATIVE
($ Million per Year)

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	24	23	24
Alfalfa	65	65	65
Sugar Beets	60	60	60
Other Field Crops	125	123	125
Rice	401	396	402
Truck Crops	397	397	397
Tomatoes	218	218	218
Deciduous Orchard	370	370	370
Small Grain	84	82	84
Grapes	65	65	65
Subtropical Orchard	20	20	20
Subtotal	1,829	1,819	1,830
San Joaquin River Region			
Pasture	32	32	32
Alfalfa	113	112	113
Sugar Beets	35	35	35
Other Field Crops	164	162	164
Rice	12	11	12
Truck Crops	1,869	1,868	1,869
Tomatoes	226	224	226
Deciduous Orchard	671	671	671
Small Grain	77	75	77
Grapes	553	553	553
Cotton	503	490	503
Subtropical Orchard	182	182	182
Subtotal	4,437	4,415	4,437
Tulare Lake Region			
Pasture	2	2	2
Alfalfa	111	107	112
Sugar Beets	16	16	16
Other Field Crops	107	103	108
Rice	0	0	0
Truck Crops	1,256	1,255	1,256
Tomatoes	9	9	9
Deciduous Orchard	411	411	411
Small Grain	62	58	63
Grapes	621	621	621
Cotton	713	685	716
Subtropical Orchard	584	584	584
Subtotal	3,892	3,851	3,898
Total	10,158	10,085	10,165

TABLE III-5

NET REVENUE IN NO-ACTION ALTERNATIVE
($ Million per Year)

Region	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River	268	267	268
San Joaquin River	558	558	558
Tulare Lake	522	518	522
Total	1,348	1,343	1,348

TABLE III-6

IRRIGATION WATER APPLIED IN NO-ACTION ALTERNATIVE
(Thousand Acre-Feet per Year)

Source	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River			
Surface Water	4,524	4,200	4,705
Groundwater	2,603	3,196	2,445
Total Applied	7,127	7,396	7,150
San Joaquin River			
Surface Water	4,453	3,879	4,852
Groundwater	3,427	4,446	2,856
Total Applied	7,880	8,325	7,708
Tulare Lake			
Surface Water	2,761	1,840	3,327
Groundwater	3,297	4,456	2,607
Total Applied	6,058	6,296	5,934
Total			
Surface Water	11,738	9,919	12,884
Groundwater	9,327	12,098	7,908
Total Applied	21,065	22,017	20,792

TABLE III-7

IRRIGATION WATER USE AND EFFICIENCY IN NO-ACTION ALTERNATIVE

Region	Applied Water (thousand acre-feet)	ET of Applied Water (thousand acre-feet)	Irrigation Efficiency (percent)
Sacramento River	7,126	4,703	66.0
San Joaquin River	7,880	5,658	71.8
Tulare Lake	6,058	4,469	73.8
Total	21,064	14,830	70.4

TABLE III-8

SAN FELIPE DIVISION CONDITION IN THE NO-ACTION ALTERNATIVE

Component	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
CVP Delivery (thousand acre-feet)	71	43	88
Irrigated Acres (thousand acres)	25	20	25
Value of Production ($ million)	89	64	89
Net Income ($ million)	8	6	8

ALTERNATIVE 1

The water supplies estimated in the surface water and groundwater analysis were used to estimate irrigated land use. Results for the three Central Valley regions are expressed as the difference from No-Action Alternative results in Table III-9. Changes from the No-Action Alternative are largely determined by the assumed location of land targeted for the retirement program and by the location of water contractors most affected by the reallocation of CVP contract water. The Tulare Lake Region's decline is due to the Land Retirement program. San Joaquin River Region's decline is a combination of the Land Retirement Program and additional fallowing due to reduced CVP water delivery. The predominance of cotton as the most affected crop is largely a result of the areas targeted for retirement and those losing CVP delivery: both of these occur in areas where cotton is the predominant field crop. A decline of 28,400 acres of cotton represents about 2.5 percent of No-Action Alternative cotton acreage in the Central Valley. In the Sacramento River Region, about 1,200 acres of rice accounts for most of the estimated acreage decline, but this is much less than 1 percent of rice acreage in the region Similar patterns of change are estimated under dry and wet conditions.

Table III-10 summarizes in terms of the difference from the No-Action Alternative. The valley-wide reduction in value of production is estimated to be $48 million per year. This estimate includes the effect of crop price increases expected to occur because production has declined - without this price increase the value of production would decline another $3.9 million per year. Most of the decline is in cotton, consistent with the change in acreage. The total decline in value represents less than one half of one percent of the No-Action Alternative value.

Table III-11 shows the estimated change in net farm income associated with the irrigated crops in each region. Approximately 55 percent of the total reduction in net income is attributable to increased cost of CVP water. Another 33 percent is due to the increased cost of groundwater pumping. Irrigation system cost increases account for about 9 percent of the total reduction. The small change in profit associated with reduced crop sales includes a $5.7 million direct loss from fallowed or retired land which is partly offset by a $3.9 million increase in crop revenues on remaining lands due to higher crop prices. The net income estimates are not detailed by crop because the analysis treats the farm as an entire operation. Different water sources are not designated to specific crops, so an increase in water cost cannot be apportioned to individual crops.

TABLE III-9

IRRIGATED ACREAGE IN ALTERNATIVE 1 COMPARED TO NO-ACTION ALTERNATIVE

(Thousand Acres)

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	-0.3	-0.5	-0.2
Alfalfa	0.1	0.0	0.1
Sugar Beets	0.0	0.0	0.0
Other Field Crops	0.0	-0.1	-0.1
Rice	-1.2	-1.6	-1.3
Truck Crops	0.0	0.0	0.0
Tomatoes	0.0	0.0	0.0
Deciduous Orchard	0.0	0.0	0.0
Small Grain	-0.1	0.1	-0.1
Grapes	0.0	0.0	0.0
Subtropical Orchard	0.0	0.0	0.0
Subtotal	-1.5	-2.1	-1.6
San Joaquin River Region			
Pasture	-1.2	-0.0	-0.5
Alfalfa	-2.7	-0.1	-2.4
Sugar Beets	-0.2	-1.6	-0.2
Other Field Crops	-3.4	-0.0	-3.0
Rice	-0.1	0.0	-0.1
Truck Crops	-0.6	-0.0	-0.6
Tomatoes	-1.8	0.1	-1.7
Deciduous Orchard	-0.1	0.0	-0.1
Small Grain	-1.9	0.0	-1.8
Grapes	-0.1	-0.1	-0.1
Cotton	-18.7	-17.6	-18.0
Subtropical Orchard	0.0	0.0	0.0
Subtotal	-30.8	-19.33	-28.5
Tulare Lake Region			
Pasture	-0.2	-0.2	-0.2
Alfalfa	-2.5	-2.7	-2.6
Sugar Beets	-0.2	-0.2	-0.2
Other Field Crops	-1.7	-1.7	-1.7
Rice	0.0	0.0	0.0
Truck Crops	-0.3	-0.2	-0.3
Tomatoes	0.0	0.0	0.0
Deciduous Orchard	-0.1	-0.1	-0.1
Small Grain	-.8	-0.9	-0.9
Grapes	-0.1	-0.1	-0.1
Cotton	-9.7	-10.0	-10.4
Subtropical Orchard	0.0	0.0	0.0
Subtotal	-15.6	-16.1	-16.5
Total	-47.9	-37.53	-46.6

NOTE:
Information on the San Felipe Division included in a separate table.

TABLE III-10

CHANGE IN GROSS REVENUE IN ALTERNATIVE 1 COMPARED TO NO-ACTION ALTERNATIVE

($ Million per Year)

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	0.00	-0.05	-0.00
Alfalfa	0.26	0.18	0.25
Sugar Beets	0.01	-0.00	0.01
Other Field Crops	-0.02	-0.07	-0.03
Rice	-0.99	-1.36	-1.04
Truck Crops	0.03	0.02	0.03
Tomatoes	0.38	0.32	0.36
Deciduous Orchard	0.04	0.04	0.04
Small Grain	-0.02	0.02	-0.01
Grapes	0.01	0.01	0.01
Subtropical Orchard	0.00	0.00	0.00
Subtotal	-0.30	-0.89	-0.38
San Joaquin River Region			
Pasture	-0.20	-0.17	-0.07
Alfalfa	-1.29	-1.43	-1.09
Sugar Beets	-0.15	-0.13	-0.15
Other Field Crops	-2.09	-1.89	-1.81
Rice	-0.07	-0.03	-0.07
Truck Crops	-3.44	-3.21	-3.38
Tomatoes	-2.33	-2.22	-2.26
Deciduous Orchard	-0.12	-0.12	-0.12
Small Grain	-0.98	-0.90	-0.90
Grapes	-0.04	-0.04	-0.04
Cotton	-20.54	-19.42	-19.72
Subtropical Orchard	0.00	-0.00	-0.00
Subtotal	-31.25	-29.56	-29.61
Tulare Lake Region			
Pasture	-0.04	-0.05	-0.04
Alfalfa	-1.16	-1.38	-1.21
Sugar Beets	-0.13	-0.13	-0.14
Other Field Crops	-1.13	-1.11	-1.11
Rice	0.00	0.00	0.00
Truck Crops	-1.74	-1.35	-1.89
Tomatoes	-0.02	-0.02	-0.03
Deciduous Orchard	-0.11	-0.11	-0.11
Small Grain	-0.41	-0.51	-0.43
Grapes	-0.16	-0.16	-0.16
Cotton	-9.60	-10.04	-10.34
Subtropical Orchard	-0.03	-0.03	-0.03
Subtotal	-14.53	-14.89	-15.49
Total	-46.08	-45.34	-45.48

NOTE:
Information on the San Felipe Division included in a separate table.

TABLE III-11

NET REVENUE IN ALTERNATIVE 1 COMPARED TO NO-ACTION ALTERNATIVE
($ Million per Year)

Region	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River	-1.44	-4.40	0.08
San Joaquin River	-35.59	-27.67	-32.69
Tulare Lake	-15.64	-10.15	-17.48
Total	-52.67	-42.21	-50.09
NOTE: Information on the San Felipe Division included in a separate table.			

Table III-12 shows the difference in the applied water between Alternative 1 and No-Action Alternative.

TABLE III-12

CHANGE IN IRRIGATION WATER APPLIED IN ALTERNATIVE 1 COMPARED TO NO-ACTION ALTERNATIVE
(Thousand Acre-Feet)

Source	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River			
Surface Water	-39	-95	-11
Groundwater	25	75	-3
Total Applied	-14	-20	-14
San Joaquin River			
Surface Water	-302	-282	-246
Groundwater	134	110	90
Total Applied	-168	-172	-156
Tulare Lake			
Surface Water	-22	1	-49
Groundwater	-44	-75	-19
Total Applied	-66	-74	-68
Total			
Surface Water	-363	-376	-306
Groundwater	115	110	68
Total Applied	-248	-266	-238

The net reduction in surface water delivered of 364,000 acre-feet includes an overall decline in CVP water application of about 385,000 acre-feet and an increase of about 21,000 acre-feet in SWP agricultural delivery in Tulare Lake Region. Most of the CVP water reduction occurs in San Joaquin River Region, primarily in the San Luis and Delta Mendota Service Areas on the west side of the region.

Of the net 364,000 acre-feet loss of surface water, about 155,000 acre-feet is saved from 48,000 acres of fallowed or retired lands, 115,000 acre-feet is replaced with groundwater pumping, and including tailwater and deep percolation.

Table III-13 shows average irrigation efficiency by region. Average irrigation efficiency is unchanged in the Sacramento River and Tulare Lake Regions. Irrigation efficiency increases in the San Joaquin River Region, rising from 71.8 percent in No-Action Alternative to 72.4 percent in Alternative 1. Irrigation efficiency rises about 0.3 percent valley-wide.

TABLE III-13

IRRIGATION WATER USE AND EFFICIENCY IN ALTERNATIVE 1

Region	Applied Water (thousand acre-feet)	ET of Applied Water (thousand acre-feet)	Irrigation Efficiency (percent)
Sacramento River	7,112	4,697	66.0
San Joaquin River	7,712	5,583	72.4
Tulare Lake	5,991	4,429	73.9
Total	20,815	14,709	70.7

Note that this average accounts for a reduction of over 28,000 acres of cotton, which is irrigated at 78 percent efficiency on average. In some subregions, efficiency actually declines because of the disproportionate reduction in cotton acreage relative to less efficiently irrigated crops.

The analysis also considers costs paid by consumers of agricultural goods. Reduced production of farm goods and the increase in their prices results in a loss to consumers because more of their income must be spent on the goods and they may not be able to purchase as much as they would in the No-Action Alternative condition. This may occur both for businesses who make products that depend on irrigated agriculture for inputs, such as dairies and fabrics, as well as persons who consume irrigated products directly. For example, a reduction in Central Valley production of forage for dairy cattle means that California dairies will reduce production, substitute other local feed, or import forage from other regions or states at higher cost. Any of these responses will have some impact on price and supply of dairy products, though the size of the impact is difficult

to estimate. One way of assessing these effects is to estimate changes in consumer surplus, roughly defined as the net benefit to all consumers of a commodity. Consumers of farm commodities span a much wider area than the production regions used for other comparisons, so consumer surplus estimates are calculated for valley-wide changes in production only. Losses to consumers resulting from reduced agricultural production in Alternative 1 are estimated to be about $3.9 million per year.

Alternative 1 would decrease agricultural revenues from U.S. Department of Agriculture (USDA) farm programs because retired land would lose eligibility for farm program payments. These revenues are an expense for the federal government. Table III-14 shows agricultural commodity acreage idled by Alternative 1 and the a total reduction of about $3.8 million in annual farm program costs. Cost savings are estimated based on average deficiency payment rates over the 1987 to 1990 period. Most of the cost savings is associated with the retirement or permanent fallowing of cotton acreage. Some additional cost savings may also result indirectly from higher crop prices.

TABLE III-14

ACREAGE OF COMMODITY CROPS RETIRED AND CORRESPONDING REDUCTION IN FEDERAL FARM PROGRAM COSTS IN ALTERNATIVE 1

Region	Commodity Acreage Retired (thousand acres)	Farm Program Cost Savings ($ million per year)
Sacramento River	1.3	0.4
San Joaquin River	24.2	2.2
Tulare Lake	12.3	1.2
Total	37.8	3.8

The 1996 Farm Bill recently signed into law revises the way commodity payments are determined, and decouples the size of the payment from the actual price and production level. There remains, however, some uncertainty about how USDA will handle lands that are part of a grower's base acreage yet are retired or fallowed as CVPIA is implemented. For purposes of analysis we assume that USDA will remove such lands from the grower's base acreage and reduce the farm program payment accordingly.

The value of irrigated land depends significantly upon the quantity and variability of the water supply available, and on the profitability of farming. The San Joaquin River Region has the largest potential reduction in land value based on the profitability of farming alone. The reduction in annual net income is estimated at $35.6 million per year spread over about 2.6 million acres, for a reduction in net income per acre of about $14 per year. A simple method to estimate land value is to calculate the present value of the stream of profit earned on the land. The net present value of $14 per year at 8 percent interest equals about $175 per acre, so the average reduction in land value is about $175 per acre. The actual reduction would be greater in local areas most affected by higher water cost and reduced delivery, but some of this loss would be mitigated by payments from the Land Retirement program. Land values could potentially increase in regions unaffected by reduced delivery or higher costs as a result of higher crop prices.

Conservation and measurement costs may occur both at the farm and the district level. On-farm conservation costs are reflected in the irrigation cost estimates discussed above. District costs may result from either mandatory conservation requirements or discretionary conservation guidelines.

For districts that do not currently measure delivery to each customer, the cost of achieving an acceptable accuracy of measurement could be significant. The estimated annual cost of the measurement hardware is $123 per turnout. The entire measurement program cost per turnout would be $470 to $670 per year. Depending on the acres served per turnout (typical areas are 20 to 200 acres), the cost per acre could range from $4 to $33 per year. Typical production costs per acre range from $300 to $800 for row crops to over $2000 for permanent crops. Therefore, new water measurement costs could be as high as 10 percent of production costs in locations where low production costs per acre coincide with unmeasured water deliveries to small fields. The cost of measurement is not expected to be significant on a regional basis, but costs could be important for some districts in the Sacramento Valley.

Under Alternative 1 about 18,000, 17,000, and 13,000 less acre-feet less would be delivered in average, dry and wet conditions, respectively to the San Felipe Division. Table III-15 summarizes the estimated impacts of Alternative 1 to agricultural deliveries and economics in the San Felipe Unit.

TABLE III-15

SAN FELIPE DIVISION IMPACTS IN ALTERNATIVE 1 COMPARED TO NO-ACTION ALTERNATIVE

Component	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
CVP Delivery (thousand acre-feet)	-18	-17	-13
Irrigated Acres (thousand acres)	-9	-8	-7
Value of Production ($ million)	-31	-29	-21
Net Income ($ million)	-3	-3	-3

ALTERNATIVE 2

Alternative 2 includes the same assumptions for the agricultural production analysis as Alternative 1, with the addition of water acquisition for Level 4 refuge supply and targeted instream flow needs on the east side San Joaquin River tributaries (Merced, Tuolumne, and Stanislaus rivers), with acquisition limited to an amount achievable within the limits of the Restoration Fund. In order to prevent groundwater replacement of acquired surface water, the analysis attempted to hold groundwater pumping to no more than the Alternative 1 level in subregions where water is acquired.

Changes from No-Action Alternative are determined by land targeted for the retirement program and by the (b)(2) water, as in Alternative 1, plus lands fallowed due to water acquisition. The San Starting from DWR's 2020 baseline land use, the water supplies estimated in the surface water and groundwater analysis were used to estimate resulting irrigated land use. Results are summarized for the three Central Valley regions and compared to the No-Action Alternative results in Table III-16.

TABLE III-16

CHANGE IN IRRIGATED ACREAGE IN ALTERNATIVE 2 COMPARED TO NO-ACTION ALTERNATIVE

(Thousand Acres)

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	0.4	-0.2	0.3
Alfalfa	0.0	-0.2	0.0
Sugar Beets	-0.1	-0.1	-0.1
Other Field Crops	-1.0	-1.3	-1.0
Rice	-4.3	-5.0	-4.5
Truck Crops	0.0	0.0	0.0
Tomatoes	-0.1	-0.2	-0.1
Deciduous Orchard	0.0	0.0	0.0
Small Grain	-0.7	-0.9	-0.7
Grapes	0.0	0.0	0.0
Subtropical Orchard	0.0	0.0	0.0
Subtotal	-5.8	-7.9	-6.1
San Joaquin River Region			
Pasture	-12.4	-12.3	-11.4
Alfalfa	-9.8	-10.0	-9.2
Sugar Beets	-0.4	-0.4	-0.4
Other Field Crops	-8.9	-8.9	-8.4
Rice	-0.9	-0.9	-0.8
Truck Crops	-0.7	-0.7	-0.7
Tomatoes	-2.3	-2.2	-2.2
Deciduous Orchard	-0.7	-0.7	-0.7
Small Grain	-2.9	-3.3	-2.6
Grapes	-0.3	-0.3	-0.3
Cotton	-25.5	-24.6	-24.3
Subtropical Orchard	0.0	0.0	0.0
Subtotal	-64.8	-64.3	-61.0
Tulare Lake Region			
Pasture	-0.1	-0.2	-0.1
Alfalfa	-2.2	-3.1	-3.0
Sugar Beets	-0.2	-0.2	-0.2
Other Field Crops	-1.3	-1.8	-1.6
Rice	0.0	0.0	0.0
Truck Crops	-0.3	-0.2	-0.3
Tomatoes	0.0	0.0	0.0
Deciduous Orchard	-0.1	-0.1	-0.1
Small Grain	-0.4	-1.0	-0.6
Grapes	-0.1	-0.1	-0.1
Cotton	-9.3	-11.4	-11.3
Subtropical Orchard	0.0	0.0	0.0
Subtotal	-14	-18.1	-17.3
Total	-84.6	-90.3	-84.4

NOTE:
Impacts in the San Felipe Division are the same as for Alternative 1.

The Joaquin River Region shows the largest decline in acreage, about 65,000 acres (2.5 percent), followed by the Tulare Lake Region acreage which declines by 14,000 (0.7 percent).

The Sacramento River Region shows a decline of about 6,000 acres (0.3 percent). Total reduction is about 85,000 acres, or about 1.3 percent of the study area's No-Action Alternative irrigated acreage.

The San Joaquin River Region's decline is caused by a combination of the Land Retirement Program, additional fallowing due to reduced CVP delivery, and fallowing due to water acquisition. The predominance of cotton as the most affected crop is largely a result of the areas targeted for retirement and those losing CVP delivery: both of these occur in areas where cotton is the predominant field crop. A decline of 34,800 acres represents about 3 percent of No-Action Alternative cotton acreage in the Central Valley. Pasture, alfalfa hay, and field crops decline primarily because of east side water acquisition. In the Sacramento River Region, about 4,300 acres of rice (about 1 percent) accounts for most of the estimated acreage reduction.

The Tulare Lake Region decline is due to the Land Retirement program. Acreage actually declines less in Alternative 2 than in Alternative 1. This occurs because the additional land fallowed for water acquisition creates an economic incentive for the fallowed crops to shift to other regions. In other words, even though land has been fallowed for water acquisition, the demand for the crops grown on that land still exists, and some of that demand is met by production in other regions. Similar patterns of change are estimated under dry and wet conditions.

The valley-wide reduction in value of production is estimated to be $66.5 million per year. This estimate accounts for crop price increases expected to occur because production has declined. (Without this price increase the value of production would decline another $7.2 million per year). Most of the $66.5 million decline is in the cotton and other field crop categories, consistent with the change in acreage. The total decline in value of production represents less than one percent of the No-Action Alternative value. Table III-17 summarizes the change from No-Action Alternative in the value of production by region and crop.

The estimated change in net revenue under the average 1922-1990 condition is shown in Table III-18. Dry and wet conditions would show similar relationships to the average as in Alternative 1.

Approximately $65 million in lost net revenue is offset by a $7 million increase from higher crop prices plus $17.5 million in revenue from selling water for restoration purposes. The net result is a decline in net revenue of about $40.4 million per year. Most of this ($25.6 million) is in the San Joaquin River region, with $13.0 million in the Tulare Lake Region and about $0.1 million in the Sacramento River Region. The losses are similar to the estimates shown for Alternative 1 (Table III-11).

Table III-19 shows the difference in water applied for crop growth between Alternative 2 and the No-Action Alternative. The numbers include the net effect of reductions in CVP delivery, increases in SWP delivery in Tulare Lake Region, reductions due to water acquisition, and changes in groundwater use. The most important difference from Alternative 1 is the amount of

TABLE III-17

CHANGE IN GROSS REVENUE IN ALTERNATIVE 2 COMPARED TO NO-ACTION ALTERNATIVE

($ Million per Year)

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	0.44	0.35	0.40
Alfalfa	0.47	0.39	0.48
Sugar Beets	-0.05	-0.07	-0.05
Other Field Crops	-0.43	-0.60	-0.44
Rice	-3.55	-4.12	-3.71
Truck Crops	-0.03	-0.06	-0.03
Tomatoes	0.24	0.17	0.22
Deciduous Orchard	0.11	0.11	0.11
Small Grain	-0.21	-0.26	-0.20
Grapes	0.03	0.03	0.03
Subtropical Orchard	0.00	0.00	0.00
Subtotal	-2.98	-4.06	2.05
San Joaquin River Region			
Pasture	-2.42	-2.42	-2.23
Alfalfa	-5.00	-5.12	-4.59
Sugar Beets	-0.36	-0.35	-0.34
Other Field Crops	-5.60	-5.58	-5.30
Rice	-0.73	-0.68	-0.68
Truck Crops	-4.20	-4.11	-4.19
Tomatoes	-2.98	-2.91	-2.88
Deciduous Orchard	-0.69	-0.69	-0.69
Small Grain	-1.49	-1.67	-1.36
Grapes	-0.35	-0.35	-0.35
Cotton	-27.21	-26.32	-25.90
Subtropical Orchard	-0.03	-0.03	-0.03
Subtotal	-51.06	-50.23	-48.54
Tulare Lake Region			
Pasture	0.01	-0.02	0.00
Alfalfa	-0.55	-1.14	-1.01
Sugar Beets	-0.13	-0.15	-0.15
Other Field Crops	-0.86	-1.18	-1.06
Rice	0.00	0.00	0.00
Truck Crops	-1.61	-1.32	-1.85
Tomatoes	-0.03	-0.02	-0.03
Deciduous Orchard	-0.01	-0.01	-0.01
Small Grain	-0.22	-0.53	-0.32
Grapes	-0.01	-0.01	-0.01
Cotton	-8.99	-11.33	-11.10
Subtropical Orchard	-0.01	-0.01	-0.01
Subtotal	-12.41	-15.72	-15.55
Total	-66.45	-70.01	-62.04

NOTE:
Impacts in the San Felipe Division are the same as for Alternative 1.

TABLE III-18

CHANGE IN NET REVENUE IN ALTERNATIVE 2 COMPARED TO NO-ACTION ALTERNATIVE

($ Million per Year)

Component	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	Total
Fallowed Land	-0.7	-7.2	-1.8	-9.7
Groundwater Pumping	-1.8	-20.0	0.5	-21.3
Irrigation Cost	-0.3	-3.7	-0.8	-4.8
CVP Water Cost	-0.3	-12.5	-16.5	-29.3
Total Reduction	-3.1	-43.4	-18.6	-65.1
Increase from Higher Crop Prices	1.7	3.1	2.4	7.2
Increase from Water Sales	1.2	13.7	2.6	17.5
Combined Net Revenue Change	-0.2	-26.6	-13.6	-40.4
NOTE: Impact in the San Felipe Division are the same as for Alternative 1.				

TABLE III-19

CHANGE IN IRRIGATION WATER APPLIED IN ALTERNATIVE 2 COMPARED TO NO-ACTION ALTERNATIVE

(Thousand Acre-Feet)

Source	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River			
Surface Water	-72	-127	-43
Groundwater	38	82	7
Total Applied	-34	-45	-36
San Joaquin River			
Surface Water	-480	-479	-421
Groundwater	182	165	142
Total Applied	-298	-314	-279
Tulare Lake			
Surface Water	-39	-11	-71
Groundwater	-23	-70	-1
Total Applied	-62	-81	-72
Total			
Surface Water	-591	-617	-535
Groundwater	197	177	148
Total Applied	-394	-440	-387

water for acquired restoration. Some water is acquired in all three regions for Level 2 refuge water supply, and additional water is purchased for instream flow in the San Joaquin River Region. The net effect of water acquisition on surface water delivered is the difference between Alternative 1 and Alternative 2 levels of delivery.

Groundwater use increases more in Alternative 2 than in Alternative 1 because of a shift of acreage from the areas selling water for restoration, where groundwater substitution is not allowed, to areas not selling water, where Interior has no means to prevent additional groundwater pumping.

Table III-20 shows average irrigation efficiency by region. Irrigation efficiency is increased slightly in comparison to the No-Action Alternative (Table III-7).

TABLE III-20

IRRIGATION WATER USE AND EFFICIENCY IN ALTERNATIVE 2

Region	Applied Water (thousand acre-feet)	ET of Applied Water (thousand acre-feet)	Irrigation Efficiency (percent)
Sacramento River	7,092	4,685	66.1
San Joaquin River	7,582	5,493	72.4
Tulare Lake	5,996	4,433	73.9
Total	20,670	14,611	70.7

Valley-wide consumer surplus is used as a measure of losses to consumers caused by lower supply and higher prices of farm goods. These losses are estimated at about $7.2 million per year.

Alternative 2 would decrease agricultural revenues from U.S. Department of Agriculture (USDA) farm programs because retired land would lose eligibility for farm program payments.

These revenues are an expense for the federal government. Table III-21 shows agricultural commodity acreage idled by Alternative 2 and the direct reduction of about $6.0 million in annual farm program costs. Cost savings are estimated based on average deficiency payment rates over the 1987 to 1990 period. Most of the cost savings are associated with the retirement or permanent fallowing of cotton acreage. Some additional savings may also result indirectly from higher crop prices.

Land values in areas of higher water costs or losses of supply would be affected as in Alternative 1. Average reduction in land values in the most affected region, San Joaquin River Region, are estimated to be $175 per acre based on the regional change in net income.

TABLE III-21

ACREAGE OF COMMODITY CROPS RETIRED AND CORRESPONDING REDUCTION IN FEDERAL FARM PROGRAM COSTS IN ALTERNATIVE 2

Region	Commodity Acreage Retired (Thousand acres)	Farm Program Cost Savings ($ million per year)
Sacramento River	6.1	1.5
San Joaquin River	38.2	3.4
Tulare Lake	11.1	1.1
Total	55.3	6.0

Lands selling appurtenant water would either be unaffected or increase in value, as long as the water remained attached, or allocated, to the land. In other words, if the right to sell water is tied to ownership or control of the land, then profit from selling the water would be capitalized into the price of the land. For example, if water is sold for $10 more per acre-foot than its net value in producing crops, then at 3 acre-feet per acre, profit would increase by $30 per acre and land value might increase by $375 per acre (capitalizing the annual profit at 8 percent). But if the right to sell water is separated from ownership of land, then the price of that land could fall (though the decline would be more than compensated by the stream of profits on water sales).

Availability of credit for farming depends largely on the expected profitability of production, the risk or variability of profitability, and the collateral available to secure the lender's money. Therefore, changes that reduce profit, increase risk, or reduce the value of land can be expected to reduce lenders' willingness to lend money or interest rates they charge may increase. The same potential increases in risk and reduction in profit discussed in Alternative 1 also apply in Alternative 2. Growers able to sell water for restoration can potentially increase net income and reduce risk, which would increase credit worthiness.

Conservation and measurement costs for Alternative 2 would be similar to Alternative 1. In summary, net costs of conservation provisions will probably not be significant for districts that already measure water to customers. For districts that do not currently measure delivery to each customer, the cost per acre could be $4 to $33 per year. Most other mandatory provisions are either inexpensive or would be required even without the CVPIA. Discretionary provisions may be avoided if their costs are burdensome or the costs exceed the benefits.

Alternative 2 impacts in the San Felipe Division are the same as for Alternative 1 because this area is not affected by the Alternative 2 Water Acquisition Program.

ALTERNATIVE 3

The water supplies estimated in the surface water and groundwater analysis were used to estimate resulting irrigated land use. Results are summarized for the three Central Valley regions and compared to the No-Action Alternative results in Table III-22.

TABLE III-22

CHANGE IN IRRIGATED ACREAGE IN ALTERNATIVE 3 COMPARED TO NO-ACTION ALTERNATIVE (Thousand Acres)

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	3.4	3.1	3.4
Alfalfa	.8	0.8	0.9
Sugar Beets	-0.1	-0.1	-0.1
Other Field Crops	-1.1	-1.4	-1.0
Rice	-4.6	-5.5	-4.6
Truck Crops	0.0	0.0	0.0
Tomatoes	-0.1	-0.2	-0.1
Deciduous Orchard	0.0	0.0	0.0
Small Grain	-0.8	-1.3	-0.8
Grapes	0.0	0.0	0.0
Subtropical Orchard	0.0	0.0	0.0
Subtotal	-2.5	-4.6	-2.3
San Joaquin River Region			
Pasture	-64.1	-64.5	-63.6
Alfalfa	-40.2	-40.3	-39.8
Sugar Beets	-0.8	-0.8	-0.8
Other Field Crops	-60.3	-60.3	-59.9
Rice	-3.6	-3.7	-3.6
Truck Crops	-1.0	-1.0	-1.0
Tomatoes	-2.6	-2.6	-2.6
Deciduous Orchard	-10.9	-10.9	-10.9
Small Grain	-15.8	-16.0	-15.7
Grapes	-3.3	-3.3	-3.3
Cotton	-38.5	-37.4	-37.8
Subtropical Orchard	-0.1	-0.1	-0.1
Subtotal	-177.1	-176.4	-175.5
Tulare Lake Region			
Pasture	0.0	0.0	0.0
Alfalfa	-0.7	-1.8	-1.3
Sugar Beets	-0.2	-0.2	-0.2
Other Field Crops	-1.6	-2.3	-1.7
Rice	0.0	0.0	0.0
Truck Crops	-0.3	-0.3	-0.3
Tomatoes	0.0	0.0	0.0
Deciduous Orchard	-0.1	-0.1	-0.1
Small Grain	-0.7	-1.3	-0.6
Grapes	0.0	0.0	0.0
Cotton	-9.5	-12.2	-11.3
Subtropical Orchard	0.0	0.0	0.0
Subtotal	-13.1	-18.2	-15.5
Total	-190.2	-194.6	-191.0

NOTE:
Impacts in the San Felipe Division are the same as for Alternative 1.

The acreage reduction in the San Joaquin River Region is caused by a combination of the Land Retirement Program, additional fallowing due to reduced CVP delivery, and substantial fallowing due to water acquisition. Pasture, alfalfa hay, cotton, and other field crops show the largest reduction. Cotton reduction occurs mostly on the west side of the Region, while pasture, alfalfa hay, and field crops decline primarily as a result of east side water acquisition.

The reduction in Tulare Lake Region is due largely to the Land Retirement program. Acreage actually declines less in Alternative 3 than in Alternative 1. This occurs because the additional land fallowed for water acquisition creates an economic incentive for the fallowed crops to shift to other regions. In other words, even though land has been fallowed for water acquisition, the demand for the crops grown on that land still exists, and some of that demand is met by increased acreage in other regions.

In the Sacramento River Region, about 4,600 acres of rice (about 1 percent) is fallowed, but this reduction is partly offset by increases in pasture and hay acreage. The significant fallowing of crops in the San Joaquin River Region causes shifting of some production into the Sacramento Valley Region.

The reduction in value of production is estimated to be $158.3 million per year valley-wide (Table III-23). This estimate accounts for crop price increases expected to occur because production has declined. (Without this price increase the value of production would decline another $22.2 million per year). Most of the decline is in the field crop categories, consistent with the change in acreage. The reduction in value produced from deciduous orchards is also notable even though the acreage decline is relatively small. The total decline in value of production represents about 1.6 percent of the No-Action Alternative value.

Table III-24 summarizes the changes in net revenue as gross revenues for the average 1922-1990 condition. Dry and wet conditions would show similar relationships to the average as in Alternative 1 (Table III-11).

Approximately $86 million in lost net revenue is offset by about $22 million increase from higher crop prices plus $218 million in revenue from selling water for restoration purposes.

The net result is an increase in net revenue of about $155 million per year. This increase masks significant winners and losers, with winners being growers able to sell water at a high price, and losers being primarily CVP contract water users. Their losses are similar to the estimates shown for Alternative 1 (Table III-11).

Table III-25 shows the difference in water applied between Alternative 3 and the No-Action Alternative. These estimates include the net effect of reductions in CVP delivery, increases in SWP delivery in Tulare Lake Region, reductions due to water acquisition, and changes in groundwater use.

TABLE III-23

CHANGE IN GROSS REVENUE IN ALTERNATIVE 3 COMPARED TO NO-ACTION ALTERNATIVE

($ Million per Year)

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	2.56	2.38	2.51
Alfalfa	2.05	1.78	2.09
Sugar Beets	-0.05	-0.15	-0.04
Other Field Crops	-0.55	-1.17	-0.52
Rice	-3.71	-4.64	-3.83
Truck Crops	-0.03	-0.14	-0.02
Tomatoes	0.29	0.13	0.30
Deciduous Orchard	2.01	2.01	2.01
Small Grain	-0.26	-0.77	-0.24
Grapes	0.18	0.18	0.18
Subtropical Orchard	0.00	0.00	0.00
Subtotal	2.49	-0.39	2.44
San Joaquin River Region			
Pasture	-13.96	-14.15	-13.83
Alfalfa	-21.90	-22.23	-21.60
Sugar Beets	-0.70	-0.73	-0.70
Other Field Crops	-39.12	-39.31	-38.88
Rice	-2.96	-3.02	-2.95
Truck Crops	-6.26	-6.24	-6.27
Tomatoes	-3.55	-3.50	-3.47
Deciduous Orchard	-12.22	-12.22	-12.22
Small Grain	-8.49	-8.76	-8.42
Grapes	-4.21	-4.21	-4.21
Cotton	-41.23	-39.75	-40.26
Subtropical Orchard	-0.20	-0.20	-0.20
Subtotal	-154.80	-154.32	-153.01
Tulare Lake Region			
Pasture	0.19	0.17	0.19
Alfalfa	2.31	1.66	1.85
Sugar Beets	-0.12	-0.14	-0.15
Other Field Crops	-1.10	-1.52	-1.16
Rice	0.00	0.00	0.00
Truck Crops	-1.72	-1.46	-1.94
Tomatoes	-0.02	-0.03	-0.03
Deciduous Orchard	1.98	1.98	1.98
Small Grain	-0.40	-0.77	-0.36
Grapes	1.88	1.88	1.88
Cotton	-8.98	-11.72	-11.13
Subtropical Orchard	0.05	0.05	0.05
Subtotal	-5.94	-9.90	-8.82
Total	-160.74	-164.22	-161.83

NOTE:
Impacts in the San Felipe Division are the same as for Alternative 1.

TABLE III-24

CHANGE IN NET REVENUE IN ALTERNATIVE 3 COMPARED TO NO-ACTION ALTERNATIVE

Component	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	Total
Fallowed Land	-0.5	-27.4	-1.5	-29.4
Groundwater Pumping	-2.3	-20.3	0.3	-22.3
Irrigation Cost	-0.3	-3.5	-0.8	-4.6
CVP Water Cost	-0.3	-12.5	-16.5	-29.3
Total Reduction	-3.4	-63.7	-18.5	-85.6
Increase from Higher Crop Prices	6.4	7.4	8.4	22.2
Increase from Water Sales	1.2	214.7	2.6	218.5
Combined Net Revenue Change	4.2	158.4	-7.5	155.1
NOTE: Impacts in the San Felipe Division are the same as for Alternative 1.				

TABLE III-25

CHANGE IN IRRIGATION WATER APPLIED IN ALTERNATIVE 3 COMPARED TO NO-ACTION ALTERNATIVE (Thousand Acre-Feet)

Source	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River			
Surface Water	-71	-125	-42
Groundwater	64	98	34
Total Applied	-7	-27	-8
San Joaquin River			
Surface Water	-1,115	-1,047	-1,101
Groundwater	191	62	203
Total Applied	-924	-985	-898
Tulare Lake			
Surface Water	-35	-6	-72
Groundwater	-22	-72	5
Total Applied	-57	-78	-67
Total			
Surface Water	-1,221	-1,178	-1,215
Groundwater	233	88	242
Total Applied	-988	-1,090	-973

The most important difference from Alternative 1 is the amount of water acquired for restoration. Some water is acquired in all three regions for Level 2 refuge water supply, and additional water is purchased for instream flow in the San Joaquin River Region. Because Alternative 3 does not restrict acquisition based on the restoration fund, substantially more water is acquired on the San Joaquin River tributaries than in Alternative 2.

Groundwater use increases more in Alternative 3 than in Alternative 1 (233,000 acre-feet versus 115,000 acre-feet). This occurs because of a shift of acreage from the areas selling water for restoration, where groundwater substitution is not allowed, to areas not selling water, where Interior has no means to prevent additional groundwater pumping.

Table III-26 shows average irrigation efficiency by region. Average irrigation efficiency declines slightly in the Sacramento River Region compared to the No-Action Alternative, from 66 to 65.9 percent. This is a result of a shift into crops (primarily irrigated pasture) that have a lower irrigation efficiency than the No-Action Alternative Regional average. Irrigation efficiency increases in the San Joaquin River Region, rising from 71.8 percent in the No-Action Alternative to 72.6 percent in Alternative 3. The irrigation efficiency rises about 0.3 percent valley-wide, similar to Alternatives 1 and 2.

TABLE III-26

IRRIGATION WATER USE AND EFFICIENCY IN ALTERNATIVE 3

Region	Applied Water (thousand acre-feet)	ET of Applied Water (thousand acre-feet)	Irrigation Efficiency (percent)
Sacramento River	7,120	4,695	65.9
San Joaquin River	6,957	5,054	72.6
Tulare Lake	6,001	4,437	73.9
Total	20,078	14,186	70.7

Valley-wide consumer surplus issued as a measure of losses to consumers caused by lower supply and higher prices of farm goods. These losses are estimated to be about $26.6 million per year.

Alternative 3 would decrease revenues from USDA farm programs because retired land would lose eligibility for farm program payments. These revenue decreases are a cost reduction for the federal government. Table III-27 shows agricultural commodity acreage idled by Alternative 3 and reduction of about $10.6 million in annual farm program costs.

These cost savings are estimated based on average deficiency payment rates over the 1987 to 1990 period. About one half of the cost savings is associated with the retirement or permanent fallowing of cotton acreage. Some additional savings may also result indirectly from higher crop prices. The 1996 Farm Bill recently signed into law revises the way commodity payments are determined, and decouples the size of the payment from the actual price and production level.

For purposes of analysis we assume that USDA will remove such lands from the grower's base acreage and reduce the farm program payment accordingly.

TABLE III-27

ACREAGE OF COMMODITY CROPS RETIRED AND CORRESPONDING REDUCTION IN FEDERAL FARM PROGRAM COSTS IN ALTERNATIVE 3

Region	Commodity Acreage Retired (thousand acres)	Farm Program Cost Savings ($ million per year)
Sacramento River	6.5	1.6
San Joaquin River	118.2	7.9
Tulare Lake	11.9	1.1
Total	136.6	10.6

Land values in areas of higher water costs or losses of supply would be reduced. Average reduction to land values in the most affected region, San Joaquin River Region, could be $175 per acre based on the regional change in net income.

Lands selling appurtenant water would either be unaffected or increase in value, as long as the water remained attached, or allocated, to the land. In other words, if the right to sell water in tied to ownership or control of the land, then profit from selling the water would be capitalized into the price of the land. For example, if water is sold for $20 more per acre-foot than its net value in producing crops, then at 3 acre-feet per acre, profit would increase by $60 per acre and land value might increase by $750 per acre (capitalizing the annual profit at 8 percent). But if the right to sell water is separated from ownership of land, then the price of that land could fall (though the decline would be more than compensated by the stream of profits on water sales).

Conservation and measurement costs for Alternative 3 would be similar to Alternative 1. Alternative 3 impacts in the San Felipe Division are the same as for Alternative 1. This area is not affected by the Alternative 3 Water Acquisition Program.

ALTERNATIVE 4

Alternative 4 includes the same assumptions for the agricultural production analysis as Alternatives 1, 2, and 3, with additional water acquisition for instream flow needs in the San Joaquin, Mokelumne, Calaveras, Yuba, and Feather Rivers. Acquisition is targeted to meet flow needs for salmon and steelhead on these streams, and is not limited to what is achievable within the restoration fund. In order to prevent groundwater replacement of acquired surface water, the analysis attempted to hold groundwater pumping to no more than the Alternative 1 level in subregions where water is acquired.

The water supplies estimated in the surface water and groundwater analysis were used to estimate resulting irrigated land use. Results are summarized for the three Central Valley regions and compared to the No-Action Alternative results in Table III-28.

TABLE III-28

CHANGE IN IRRIGATED ACREAGE IN ALTERNATIVE 4 COMPARED TO NO-ACTION ALTERNATIVE

(Thousand Acres)

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	-10.7	-14.0	-10.5
Alfalfa	-0.5	-1.1	-0.4
Sugar Beets	-0.4	-0.5	-0.3
Other Field Crops	-3.2	-4.7	-3.0
Rice	-18.2	-27.0	-18.4
Truck Crops	0.0	-0.1	0.0
Tomatoes	-0.2	-0.3	-0.2
Deciduous Orchard	-0.2	-0.2	-0.2
Small Grain	-2.3	-4.6	-2.2
Grapes	-0.1	-0.1	-0.1
Subtropical Orchard	0.0	0.0	0.0
Subtotal	-35.8	-52.6	-35.3
San Joaquin River Region			
Pasture	-76.2	-75.2	-75.4
Alfalfa	-42.6	-42.8	-42.2
Sugar Beets	-1.0	-1.0	-1.0
Other Field Crops	-63.3	-63.4	-62.8
Rice	-4.4	-4.3	-4.4
Truck Crops	-1.1	-1.1	-1.1
Tomatoes	-2.8	-2.7	-2.7
Deciduous Orchard	-14.2	-14.2	-14.2
Small Grain	-16.8	-17.6	-16.5
Grapes	-4.2	-4.2	-4.2
Cotton	-39.9	-38.9	-39.0
Subtropical Orchard	-0.1	-0.1	-0.1
Subtotal	-266.6	-265.5	-263.6
Tulare Lake Region			
Pasture	0.1	0.1	0.1
Alfalfa	-0.5	-1.4	-1.1
Sugar Beets	-0.2	-0.2	-0.2
Other Field Crops	-1.7	-2.3	-1.7
Rice	0.0	0.0	0.0
Truck Crops	-0.3	-0.2	-0.3
Tomatoes	0.0	0.0	0.0
Deciduous Orchard	0.0	0.0	0.0
Small Grain	-0.8	-1.4	-0.7
Grapes	0.0	0.0	0.0
Cotton	-9.6	-11.8	-11.3
Subtropical Orchard	0.0	0.0	0.0
Subtotal	-13.0	-17.2	-15.2
Total	-315.4	-335.3	-314.1

NOTE:
Impacts in the San Felipe Division are the same as for Alternative 1.

The differences from the No-Action Alternative are determined by land targeted for the retirement program and by the (b)(2) water, as in Alternative 1, plus lands fallowed due to water acquisition. The acreage reduction is caused by San Joaquin River Region's decline is a combination of the Land Retirement Program, additional fallowing due to reduced CVP delivery, and substantial fallowing due to water acquisition. Pasture, alfalfa hay, cotton, and other field crops show the largest acreage reduction. Cotton acquired reduction occurs mostly on the west side of the region, while pasture, alfalfa hay, and field crops decline primarily as part of east side water acquisition.

The Tulare Lake Region's acreage decline is due largely to the Land Retirement program. Acreage actually declines less in Alternative 4 than in Alternative 1. This occurs because the additional land fallowed for water acquisition creates an economic incentive for the fallowed crops to shift to other regions. In other words, even though land has been fallowed for water acquisition, the demand for the crops grown on that land still exists, and some of that demand gets met by irrigated acreage in other regions. In the Sacramento River Region, about 18,000 acres of rice (about 4 percent) and 11,000 acres of pasture (6.5 percent) account for most of the fallowed land. This is almost entirely a result of the water acquisition program. Acreage fallowed increases significantly under dry conditions (compared to the No-Action Alternative dry condition) in the Sacramento River Region, due to higher water acquisition in dry years.

The valley-wide reduction in value of production is estimated to be $181.6 million per year (Table III-29). This estimate accounts for crop price increases expected to occur because production has declined. (Without this price increase the value of production would decline another $30.6 million per year.) Most of the decline is in the field crop categories, consistent with the change in acreage. The reduction in value produced from deciduous orchard is also notable even though the acreage decline is relatively small. The total decline in value of production represents about 1.8 percent of the No-Action Alternative value.

Alternative 4 includes water acquired for restoration purposes, and the revenue from this water becomes another component of income for the agricultural sector. Table III-30 summarizes these components for the average 1922-1990 condition. Dry and wet conditions would show similar relationships to average as in Alternative 1 (Table III-11).

Approximately $94 million in lost net revenue is offset by about $31 million from higher crop prices plus an estimated $296 million in revenue from selling water for restoration purposes. The net result is an increase in net revenue of about $232 million per year. This increase masks significant winners and losers, with winners being growers able to sell water at a high price, and losers being primarily CVP contract water users. Their losses are similar to the estimates shown in Alternative 1 (Table III-11).

Table III-31 shows the difference in applied water between Alternative 4 and the No-Action Alternative. These estimates include the net effect of reductions in CVP delivery, increases in SWP delivery in Tulare Lake Region, reductions due to water acquisition, and changes in groundwater use.

The most important difference from Alternative 1 is the amount of water acquired for restoration. Some water is acquired in all three regions for Level 2 refuge water supply, and additional water is purchased for instream flow in the Sacramento River and San Joaquin River Regions. Because

TABLE III-29

CHANGE IN GROSS REVENUE IN ALTERNATIVE 4 COMPARED TO NO-ACTION ALTERNATIVE

($ Million per Year)

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	0.84	0.35	0.85
Alfalfa	1.40	1.03	1 46
Sugar Beets	-0.22	-0.33	-0.20
Other Field Crops	-1.51	-2.25	-1.43
Rice	-14.60	-21.90	-14.79
Truck Crops	-0.12	-0.24	-0.11
Tomatoes	0.21	0.04	0.22
Deciduous Orchard	2.43	2.43	2.43
Small Grain	-0.70	-1.44	-0.67
Grapes	0.10	0.10	0.10
Subtropical Orchard	0.00	0.00	0.00
Subtotal	-12.17	-22.21	-12.14
San Joaquin River Region			
Pasture	-15.88	-15.74	-15.74
Alfalfa	-22.54	-22.85	-22.27
Sugar Beets	-0.82	-0.83	-0.80
Other Field Crops	-40.42	-40.34	-40.13
Rice	-3.56	-3.46	-3.53
Truck Crops	-6.73	-6.69	-6.73
Tomatoes	-3.61	-3.57	-3.51
Deciduous Orchard	-15.96	-15.96	-15.96
Small Grain	-8.88	-9.15	-8.77
Grapes	-5.30	-5.30	-5.30
Cotton	-41.28	-40.36	-40.34
Subtropical Orchard	-0.23	-0.23	-0.23
Subtotal	-165.21	-164.48	-163.31
Tulare Lake Region			
Pasture	0.27	0.24	0.26
Alfalfa	2.54	1.98	2.18
Sugar Beets	-0.12	-0.13	-0.15
Other Field Crops	-1.09	-1.46	-1.14
Rice	0.00	0.00	0.00
Truck Crops	-1.70	-1.33	-1.83
Tomatoes	-0.02	-0.02	-0.03
Deciduous Orchard	2.67	2.67	2.67
Small Grain	-0.38	-0.77	-0.35
Grapes	2.45	2.45	2.45
Cotton	-8.95	-11.46	-10.73
Subtropical Orchard	0.06	0.06	0.06
Subtotal	-4.27	-7.77	-6.61
Total	-181.65	-194.46	-182.06

NOTE:
Impacts in the San Felipe Division are the same for Alternative 1.

TABLE III-30

CHANGE IN NET REVENUE IN ALTERNATIVE 4 COMPARED TO NO-ACTION ALTERNATIVE

Component	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	Total
Fallowed Land	-3.4	-30.4	-1.5	-35.3
Groundwater Pumping	-4.2	-21.3	0.4	-25.1
Irrigation Cost	-0.3	-3.5	-0.8	-4.6
CVP Water Cost	-0.3	-12.5	-16.5	-29.3
Total Reduction	-8.2	-67.7	-18.4	-94.3
Increase from Higher Crop Prices	8.1	12.4	10.1	30.6
Increase from Water Sales	12.3	281.1	2.7	296.1
Combined Net Revenue Change	12.2	225.8	-5.6	232.4
NOTE: Impacts in the San Felipe Division are the same as for Alternative 1.				

TABLE III-31

CHANGE IN IRRIGATION WATER APPLIED IN ALTERNATIVE 4 COMPARED TO NO-ACTION ALTERNATIVE

(Thousand Acre-Feet Per Year)

Source	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River			
Surface Water	-283	-408	-235
Groundwater	101	135	52
Total Applied	-182	-273	-183
San Joaquin River			
Surface Water	-1,254	-1,195	-1,227
Groundwater	212	94	215
Total Applied	-1,042	-1,101	-1,012
Tulare Lake			
Surface Water	-33	-2	-70
Groundwater	-21	-72	8
Total Applied	-54	-74	-62
Total			
Surface Water	-1,570	-1,605	-1,532
Groundwater	292	157	275
Total Applied	-1,278	-1,448	-1,257

Alternative 4 does not restrict acquisition based on the restoration Fund, substantially more water is acquired on the San Joaquin River tributaries than in Alternative 2.

Groundwater use increases more in Alternative 4 than in Alternative 1 (292,000 acre-feet vs. 115,000 acre-feet). This occurs because of a shift of acreage from the areas selling water for restoration, where groundwater substitution is not allowed, to areas not selling water, where Interior has no means to prevent additional groundwater pumping.

Using valley-wide consumer surplus is used as a measure of losses to consumers caused by lower supply and higher prices of farm goods. These losses are estimated to be about $31.9 million per year.

Table III-32 shows average irrigation efficiency by region. Average irrigation efficiency rises slightly in the Sacramento River Region as compared to the No-Action Alternative, from 66 to 66.2 percent. Irrigation efficiency increases in the San Joaquin River Region, rising from 71.8 percent in the No-Action Alternative to 73 percent in Alternative 4. Irrigation efficiency rises about 0.5 percent valley-wide.

TABLE III-32

IRRIGATION WATER USE AND EFFICIENCY IN ALTERNATIVE 4

Region	Applied Water (thousand acre-feet)	ET of Applied Water (thousand acre-feet)	Irrigation Efficiency (percent)
Sacramento River	6,945	4,601	66.2
San Joaquin River	6,838	4,993	73.0
Tulare Lake	6,003	4,438	73.9
Total	19,786	14,032	70.9

Alternative 4 would decrease agricultural revenues from USDA farm programs because retired land would lose eligibility for farm program payments. These revenue reductions are a cost savings for the federal government. Table III-33 shows agricultural commodity acreage idled by Alternative 4 and a reduction of about $15.8 million in annual farm program costs. Cost savings are estimated based on average deficiency payment rates over the 1987 to 1990 period. About one half of the cost savings is associated with the retirement or permanent fallowing of cotton acreage. Some additional savings may also result indirectly from higher crop prices.

TABLE III-33

ACREAGE OF COMMODITY CROPS RETIRED AND CORRESPONDING REDUCTION IN FEDERAL FARM PROGRAM COSTS IN ALTERNATIVE 4

Region	Commodity Acreage Retired (thousand acres)	Farm Program Cost Savings ($ million per year)
Sacramento River	23.7	6.3
San Joaquin River	124.4	8.4
Tulare Lake	12.0	1.1
Total	160.1	15.8

The 1996 Farm Bill recently signed into law revises the way commodity payments are determined, and decouples the size of the payment from the actual production level. For purposes of analysis we assume that USDA will remove such lands from the grower's base acreage and reduce the farm program payment accordingly.

Land values in areas of higher water costs or losses of supply would be affected similarly to Alternative 1. Average reductions in land values in the most affected region, San Joaquin River Region, could be $175 per acre based on the regional change in net income.

Areas selling water would either be unaffected or increase in land value, depending on whether the water remained attached, or allocated, to the land. In other words, if the right to sell water is tied to ownership or control of the land, then profit from selling the water would be capitalized into the price of the land. If the right to sell water is separated from ownership of land, then the price of that land could fall (though the decline would be more than compensated by the stream of profits on water sales).

Conservation and measurement costs for Alternative 4 would be similar to Alternative 1. In summary, net costs of conservation provisions will probably not be significant for districts that already measure water to customers. For districts that do not currently measure delivery to each customer, the cost per acre could be $4 to $33 per year. With the exception of measurement, most mandatory provisions are either inexpensive or would be required even without the CVPIA. Discretionary provisions may be avoided if their costs are burdensome or the costs exceed the benefits.

Alternative 4 impacts in the San Felipe Division are the same as for Alternative 1. This area is not affected by the Alternative 4 Water Acquisition Program.

ALTERNATIVE 5

Water supplies estimated in the surface water and groundwater analysis were used to estimate resulting irrigated land use. Results are summarized for the three Central Valley regions and compared to the No-Action Alternative results in Table III-34.

The San Joaquin River Region's acreage reduction is caused by of the Land Retirement Program and substantial fallowing due to water acquisition. All crops show large acreage reductions.

Tulare Lake Region's acreage reduction is due to the Land Retirement program and the acquisition of state and federal project water. Continued delivery from local surface streams (Kings, Kaweah, Tule, and Kern rivers, primarily) prevents the acreage reduction from being as much of the acreage base as in the other two regions. Cotton, alfalfa hay, and other field crop acreage are the primary crops declining.

In the Sacramento River Region, about 400,000 acres of rice (almost 85 percent of the region's rice acreage) plus substantial acreage of pasture, grains, and other field crops account for most of the acreage fallowed. This is almost entirely a result of the water acquisition program. Similar substantial amounts of acreage reduction are estimated under dry and wet conditions.

TABLE III-34

CHANGE IN IRRIGATED ACREAGE IN ALTERNATIVE 5 COMPARED TO NO-ACTION ALTERNATIVE

(Thousand Acres)

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	-122.5	-119.5	-122.7
Alfalfa	-73.1	-73.2	-73.5
Sugar Beets	-27.1	-28.1	-27.1
Other Field Crops	-156.6	-157.9	-156.9
Rice	-400.5	-401.9	-402.2
Truck Crops	-13.4	-13.9	-13.3
Tomatoes	-37.6	-39.3	-37.7
Deciduous Orchard	-17.2	-17.2	-17.2
Small Grain	-118.1	-124.5	-118.9
Grapes	-3.5	-3.5	-3.5
Subtropical Orchard	-0.1	-0.1	-0.1
Subtotal	-969.7	-979.1	-973.1
San Joaquin River Region			
Pasture	-120.2	-119.0	-119.9
Alfalfa	-132.5	-131.0	-130.5
Sugar Beets	-16.5	-16.4	-16.0
Other Field Crops	-170.7	-169.6	-168.4
Rice	-11.1	-11.1	-11.2
Truck Crops	-18.7	-19.3	-18.3
Tomatoes	-38.1	-37.9	-36.9
Deciduous Orchard	-118.5	-118.5	-118.5
Small Grain	-71.3	-70.3	-70.1
Grapes	-21.7	-21.7	-21.7
Cotton	-281.4	-275.8	-275.6
Subtropical Orchard	-0.2	-0.2	-0.2
Subtotal	-1,000.9	-990.8	-987.3
Tulare Lake Region			
Pasture	-3.7	-3.5	-3.4
Alfalfa	-81.5	-78.6	-79.0
Sugar Beets	-2.8	-2.9	-2.7
Other Field Crops	-38.3	-39.6	-35.1
Rice	0.0	0.0	0.0
Truck Crops	-2.6	-3.1	-2.6
Tomatoes	-0.4	-0.4	-0.4
Deciduous Orchard	-3.5	-3.5	-3.5
Small Grain	-11.1	-12.6	-8.9
Grapes	-2.2	-2.2	-2.2
Cotton	-211.0	-215.2	-201.7
Subtropical Orchard	-0.7	-0.7	-0.7
Subtotal	-357.8	-362.3	-340.2
Total	-2,328.4	-2,332.2	-2,300.6

NOTE:
Information on the San Felipe Division included in a separate table.

The valley-wide reduction in value of production is estimated to be $1.75 billion per year. This estimate accounts for crop price increases expected to occur because production has declined. (Without this price increase the value of production would decline another $186 million per year). Most of the decline is in the field crop categories, consistent with the change in acreage. The reduction in value produced from deciduous orchards, truck crops, and tomatoes is also substantial. Value of production increases in a few subregions due to little or no decline in acreage combined with a price increase. Table III-35 shows the decline in value of production. The loss represents about 17 percent of the No-Action Alternative value.

Table III-36 summarizes changes in net revenue for the average 1922-1990 condition.

Approximately $475 million in lost net income is offset by about $186 million from higher crop prices plus an estimated $3 billion in revenue from selling water for restoration purposes. The net result is an increase in net income of about $2.7 billion per year. This increase masks significant winners and losers, with winners being growers able to sell water at a high price, and losers being primarily CVP contract water users. Their losses are similar to the estimates shown for Alternative 1 (Table III-11).

Table III-37 shows the difference in applied water between Alternative 5 and the No-Action Alternative. These estimates include the net effect of reductions in CVP delivery, increases in SWP delivery in Tulare Lake Region, reductions due to water acquisition, and changes in groundwater use.

Groundwater use increases more in Alternative 5 than in Alternative 1 (304,000 acre-feet versus 115,000 acre-feet). This occurs because of a shift of acreage from the areas selling water for restoration, where groundwater substitution is not allowed, to areas not selling water, where Interior has no means to prevent additional groundwater pumping.

Table III-38 shows average irrigation efficiency by region. Average irrigation efficiency rises significantly in all regions, because growers would attempt to make maximum use of the remaining groundwater and Tulare Lake Region surface supply. Sacramento River Region efficiency rises to 79.3 percent compared to 66 percent in the No-Action Alternative. Irrigation efficiency in the San Joaquin River Region increases from 71.8 percent in the No-Action Alternative to 80.4 percent in Alternative 5. Tulare Lake Region efficiency rises from 73.9 to 82.2 percent. Irrigation efficiency increased about 10 percentage points, from 70.7 in the No-Action Alternative to 80.9 percent valley-wide.

The most important difference from Alternative 1 is the acquisition of water for restoration. Some water is acquired in all three regions for Level 2 refuge water supply, and all additional surface water and project water delivery is purchased for instream flow in the Sacramento River and San Joaquin River regions. Alternative 5 does not restrict acquisition based on the Restoration Fund.

Valley-wide consumer surplus issued as a measure of losses to consumers caused by lower supply and higher prices of farm goods. This loss is estimated at about $227.5 million per year. Significant price increases are estimated to occur for pasture ($3 per animal unit month), alfalfa hay ($15 per ton), rice ($6 per ton), cotton ($8 per bale), and deciduous orchard ($140 per ton, using almonds as the reference crop).

TABLE III-35

CHANGE IN GROSS REVENUE IN ALTERNATIVE 5 COMPARED TO NO-ACTION ALTERNATIVE

($ Million per Year)

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	-16.19	-15.94	-16.24
Alfalfa	-36.73	-37.31	-37.16
Sugar Beets	-19.64	-20.39	-19.70
Other Field Crops	-74.09	-74.71	-74.27
Rice	-338.02	-339.34	-339.42
Truck Crops	-53.83	-55.51	-53.29
Tomatoes	-47.17	-49.60	-47.53
Deciduous Orchard	4.97	4.97	4.97
Small Grain	-36.22	-38.01	-36.46
Grapes	-4.92	-4.92	-4.92
Subtropical Orchard	-0.10	-0.10	-0.10
Subtotal	-621.94	-630.86	-624.12
San Joaquin River Region			
Pasture	-26.33	-26.30	-26.29
Alfalfa	-71.19	-70.97	-70.00
Sugar Beets	-12.71	-12.64	-12.33
Other Field Crops	-102.63	-102.00	-101.22
Rice	-8.88	-8.84	-8.89
Truck Crops	-90.90	-93.84	-88.37
Tomatoes	-46.93	-46.48	-45.34
Deciduous Orchard	-137.53	-137.53	-137.53
Small Grain	-29.56	-29.30	-28.84
Grapes	-25.76	-25.76	-25.76
Cotton	-297.99	-292.16	-291.77
Subtropical Orchard	-0.32	-0.32	-0.32
Subtotal	-850.72	-846.14	-836.66
Tulare Lake Region			
Pasture	-0.52	-0.50	-0.43
Alfalfa	-38.92	-37.90	-37.54
Sugar Beets	-2.02	-2.17	-1.93
Other Field Crops	-23.75	-24.57	-21.72
Rice	-0.01	-0.01	-0.01
Truck Crops	-12.31	-15.24	-10.51
Tomatoes	-0.10	-0.16	-0.05
Deciduous Orchard	19.96	19.96	19.96
Small Grain	-6.02	-6.94	-4.69
Grapes	9.75	9.75	9.75
Cotton	-218.63	-223.84	-206.29
Subtropical Orchard	-1.48	-1.48	-1.48
Subtotal	-274.05	-283.10	-254.94
Total	-1,746.71	-1,760.10	-1,715.72

NOTE:
Information on the San Felipe Division included in a separate table.

TABLE III-36

CHANGE IN NET REVENUE IN ALTERNATIVE 5 COMPARED TO NO-ACTION ALTERNATIVE

Component	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	Total
Fallowed Land	-105.3	-134.5	-44.6	-284.4
Groundwater Pumping	-12.5	-31.4	-42.4	-86.3
Irrigation Cost	-18.9	-37.0	-48.3	-104.2
CVP Water Cost	0.0	0.0	0.0	0.0
Total Reduction	-136.7	-202.9	-135.3	-474.9
Increase from Higher Crop Prices	43.9	74.2	68.0	186.1
Increase from Water Sales	1,849.0	1,172.0	5.8	3,026.8
Combined Net Revenue Change	1,756.2	1,043.3	-61.5	2,738.0
NOTE: Information on the San Felipe Division included in a separate table.				

TABLE III-37

CHANGE IN IRRIGATION WATER APPLIED IN ALTERNATIVE 5 COMPARED TO NO-ACTION ALTERNATIVE

(Thousand Acre-Feet)

Source	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River			
Surface Water	-4,524	-4,200	-4,705
Groundwater	100	-425	268
Total Applied	-4,424	-4,625	-4,437
San Joaquin River			
Surface Water	-3,949	-3,518	-4,223
Groundwater	131	-519	520
Total Applied	-3,818	-4,037	-3,703
Tulare Lake			
Surface Water	-1,823	-1,320	-2,009
Groundwater	73	-526	345
Total Applied	-1,750	-1,846	-1,664
Total			
Surface Water	-10,296	-9,038	-10,937
Groundwater	304	-1,470	1,133
Total Applied	-9,992	-10,508	-9,804

TABLE III-38

IRRIGATION WATER USE AND EFFICIENCY IN ALTERNATIVE 5

Region	Applied Water (thousand acre-feet)	ET of Applied Water (thousand acre-feet)	Irrigation Efficiency (percent)
Sacramento River	2,702	2,144	79.3
San Joaquin River	4,062	3,267	80.4
Tulare Lake	4,308	3,542	82.2
Total	11,072	8,953	80.9

Alternative 5 would decrease agricultural revenues from USDA farm programs because retired land would lose eligibility for farm program payments. Table III-39 shows agricultural commodity acreage idled by Alternative 5 and the direct reduction of about $216 million in annual farm program costs. Cost savings are estimated based on average deficiency payment rates over the 1987 to 1990 period. Additional farm program cost savings may also result indirectly from higher crop prices.

TABLE III-39

ACREAGE OF COMMODITY CROPS RETIRED AND CORRESPONDING REDUCTION IN FEDERAL FARM PROGRAM COSTS IN ALTERNATIVE 5

Region	Commodity Acreage Retired (thousand acres)	Farm Program Cost Savings ($ million per year)
Sacramento River	675.2	149.0
San Joaquin River	534.5	42.7
Tulare Lake	260.4	24.3
Total	1,470.1	216.0

All areas with potential negative impacts on land values (as described in Alternative 1) can now sell water, some at a substantial profit. Therefore land values in these areas would increase, as long as the water remained attached to the land. For example, if water is sold for $100 more per acre-foot than its net value in producing crops, then at 3 acre-feet per acre, profit would increase by $300 per acre and land value might increase by $3,750 per acre (capitalizing the annual profit at 8 percent). But if the right to sell water is separated from ownership of land, then the price of that land could fall (though the decline would be more than compensated by the stream of profits on water sales). Conservation and measurement costs for Alternative 5 would not be relevant, because no CVP water would be delivered for irrigation.

Under Alternative 5 all CVP San Felipe Division delivery would be zero. Irrigated acreage would decline by about 45,300, 25,600 and 56,100 acres. This would result in a loss of agricultural production value of $142 million in an average year, $80 million in dry years, and $176 in wet years. Approximately $142 million in lost production represents about 34 percent of

the value of production in San Felipe, Santa Clara, and Santa Cruz counties (Census, 1994). These losses would be associated with net income losses of $13 to $28 million, depending on year type. Table III-40 summarizes the estimated impacts of Alternative 5 to the San Felipe Division.

TABLE III-40

SAN FELIPE DIVISION IMPACTS IN ALTERNATIVE 5 COMPARED TO NO-ACTION ALTERNATIVE

Component	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
CVP Delivery (thousand acre-feet)	-71	-43	-88
Irrigated Acres (thousand acres)	-25	-20	-25
Value of Production ($ million)	-89	-64	-89
Net Income ($ million)	-8	-6	-8

RECREATION

The impact assessment evaluated two types of changes related to recreation: recreation opportunities and recreation use. The recreation opportunities assessment evaluated how changes in reservoir elevations, river flows, and wildlife refuge water deliveries would affect the opportunities for water-related activities at key recreation facilities. The recreation use assessment evaluates how these same types of changes may affect annual recreation use at these facilities.

Impacts based on changes in recreation opportunities were assessed for major and secondary CVP and SWP reservoirs and reservoirs operated by other agencies that could be affected by implementation of the CVPIA.

Impacts based on changes in recreation opportunities and use are assessed for rivers below CVP reservoirs, SWP reservoirs, and reservoirs operated by other agencies that could be affected by implementation of the CVPIA.

Impacts on recreation are assessed for NWR and WMA in the Sacramento River Region, San Joaquin River Region, and Tulare Lake Region. Changes in annual recreation use at each refuge are estimated for wildlife observation, waterfowl hunting, and fishing assuming increased use due to increased quality of the experience.

Certain recreation sites are not included in the following discussion because conditions which could affect recreation at these sites are expected to be the same under each of the project alternatives as they are under the No-Action Alternative. Recreation sites not included in the impact summary include Whiskeytown Lake, Keswick Reservoir, Lake Natoma, Thermalito Forebay and Afterbay, Bethany Reservoir, Clear Creek, Feather River, Yuba River, Calaveras River, and the San Francisco/Bay-Delta Region.

The hydrologic modeling conducted for this analysis has not included reoperation of non-CVP and non-SWP reservoirs. Therefore, the analysis of these reservoirs and the rivers they control is presented at a more general level of detail than the analysis of the CVP and SWP facilities.

NO-ACTION ALTERNATIVE

Reservoirs

At Shasta Lake, usable surface area for boating would be constrained during 18 peak-season months (May through September) and 30 off-season months (October through April) on the main area of the lake, 34 peak-season and 46 off-season months on the McCloud River Arm, 84 peak-season months and 111 off-season months on the Pit River Arm, and 116 peak-season and 191 off-season months on the Sacramento River Arm. Boat ramps would be unusable for 21 peak-season and 30 off-season months on the McCloud River Arm, 17 peak-season and 25 off-season months on the Pit River Arm, and 19 peak-season months and 30 off-season months on the Sacramento River Arm. Marinas would be required to move facilities once during 13 peak-season periods on the main area of the lake, McCloud River Arm, and Pit River Arm and once during 21 peak-season periods on the Sacramento River Arm. The reservoir surface elevation would be below the level at which camping declines 27 peak-season months on the McCloud River Arm, two peak-season months on the Pit River Arm, and 34 peak-season months on the Sacramento River Arm. Average annual use over the 69-year hydrologic period is estimated to total 16,070,800 visitor days.

At Lake Oroville, boat ramp availability would be limited for 27 peak-season months and 43 off-season months. Usable surface area for boating would be constrained for 62 peak-season months and 96 off-season months. Marinas would be required to move facilities once during 11 peak-season periods (May-September). The reservoir would be below the level at which beach use declines for 196 peak-season months and below the level at which camping and picnicking typically decline during 23 peak-season months. Average annual use over the 69-year hydrologic period is estimated to total 1,871,000 visitor days.

At Folsom Lake, boat ramps would be unusable six peak-season months and 11 off- season months. Usable surface area for boating would be constrained 60 peak-season months and 105 off-season months. The marina would be forced to close during 83 peak-season months. Beach areas would be inundated during 95 peak-season months. The reservoir would be below the level at which camping and picnicking typically decline 175 peak-season months. Average annual use over the 69-year hydrologic period is estimated to total 3,814,800 visitor days.

Boat ramps at San Luis Reservoir would be unusable one month during the peak-season and would not be affected during the off season. Usable surface area for boating would be constrained 18 peak-season months and 17 off-season months. The reservoir would be below the level at which camping and picnicking decline 18 peak-season months.. Average annual use at San Luis Reservoir over the 69-year hydrologic period is estimated to total 274,900 visitor days.

At Millerton Lake, boat ramps would be unusable 17 peak-season months and 5 off-season months. Usable surface area for boating would be constrained 25 peak-season months and 6 off-season months. The reservoir would be below the level at which beach use declines 25 peak-

season months. Average annual use over the 69-year hydrologic period is estimated to total 992,100 visitor days.

Boat ramps at New Melones Reservoir would be unusable one peak-season month and one off-season month. Usable surface area for boating would be constrained two peak-season months five off-season months. Marinas would close during four peak-season months. The reservoir would be below the level at which beach use declines 13 peak-season months and below the level at which camping and picnicking typically decline two peak-season months. Average annual use over the 69-year hydrologic period is estimated to total 1,888,900 visitor days.

Rivers

On the upper reach of the Sacramento River (Keswick Dam to Lake Red Bluff) river flows would fall within a range that accommodates many important boating activities 329 peak-season months. These activities include power boating, drift boating, rafting, canoeing, and kayaking. River flows on the lower reach (Lake Red Bluff to Bay/Delta) would accommodate all important boating activities over the 69-year hydrologic period.

American River flows fall within the optimal range for all boating activities 111 peak-season months and below the minimum level 130 peak-season months. River flows fall below the optimal level for swimming in 104 peak-season months.

On the upper reach of the San Joaquin River (Millerton Lake to City of Merced) river flows would fall within the optimal range for canoeing 19 peak-season months. All other boating activities would experience optimal river flows for 239 peak-season months. River flows would fall below the optimal swimming level in 19 peak-season months. On the lower reach (City of Merced to the Bay-Delta), river flows would be below the optimal range for boating activities but above the minimum level for swimming during all peak-season months. Average annual use over the 69-year hydrologic period is estimated to total 93,000 visitor days.

On the upper reach of the Stanislaus River (New Melones Reservoir to City of Oakdale), flows for all types of boating would fall within the optimal range 116 peak-season months. On the lower reach (City of Oakdale to the San Joaquin River) flows would fall within the optimal range for all boating activities 23 peak-season months, but below the minimum flow necessary to conduct these activities 127 peak-season months. Average annual use for the entire Stanislaus River over the 69-year hydrologic period is estimated to total 51,700 visitor days.

On the Tuolumne River, optimal flows for all boating activities would occur in 15 peak-season months. River flows would be below the minimum for canoeing and kayaking in 230 peak-season months and below the minimum for power boating in 264 peak-season months. For swimming, river flows would fall within the optimal range in 22 peak-season months and below the minimum level in 179 peak-season months. Average annual use over the 69-year hydrologic period is estimated to total 35,900 visitor days.

Merced River flows would fall below the minimum for all boating activities 289 peak-season months. For swimming, river flows would fall within the optimal range 75 peak-season months. Average annual use over the 69-year hydrologic period is estimated to total 32,000 visitor days.

On the upper reach of the Mokelumne River (Camanche Reservoir to Woodbridge), river flows for all types of boating would fall within the optimal range in 97 peak-season months and below the minimum 15 peak season months. River flows would fall below the minimum level for swimming one peak-season month. On the lower reach (Woodbridge to the Bay-Delta), river flows would fall below the minimum for all boating activities 225 peak-season months. Flows would be below the minimum for swimming 219 peak-season months. Average annual use occurring on the Mokelumne River under the No-Action Alternative was not estimated.

Refuges and Wetlands

Under the No-Action Alternative, average annual visitation to Sacramento Valley wildlife refuges (Sacramento, Sutter, Colusa, and Delevan NWRs and Gray Lodge WMA) is estimated to total 101,200 visitor days. Nonconsumptive activities such as wildlife viewing would account for approximately 49,700 visitor days, followed by waterfowl hunting at 45,000 visitor days, and fishing use at 6,500 visitor days. Gray Lodge WMA would account for approximately 36 percent of the waterfowl hunting on the refuges, followed by Sacramento NWR (29 percent), Sutter NWR (19 percent), Colusa NWR (9 percent), and Delevan (7 percent). Waterfowl hunting on private hunting lands is estimated to total 935,000 hunter days annually.

Average annual visitation to the San Joaquin River Region wildlife refuges (San Luis, Mendota, and Merced NWRs and Volta and Los Banos WMAs) is estimated to total 72,900 visitor days. Wildlife viewing would account for approximately 35,800 visitor days, followed by waterfowl hunting at 32,500 visitor days, and fishing use at 4,600 visitor days. Waterfowl hunting on private hunting lands is estimated to total 935,000 hunter days annually.

Average annual visitation to the wildlife refuges in the Tulare Lake Region (Kern and Pixley NWRs) is estimated to total 4,400 visitor days. Wildlife viewing would account for approximately 3,900 visitor days followed by fishing use at 500 visitor days. waterfowl hunting on private lands is estimated to total 58,000 hunter days annually.

ALTERNATIVE 1

Reservoirs

At Shasta Lake, usable surface area for boating would be constrained for one more peak-season month and two fewer off-season months on the main area of the lake, seven more peak-season and two more off-season months on the McCloud River Arm, 15 more peak-season and 32 more off-season months on the Pit River Arm and four more peak-season and 33 more off-season months on the Sacramento River Arm. Boat ramp availability on the main area of the lake would be the same as under the No-Action Alternative, constrained for seven more peak-season months and two more off-season months on the McCloud River Arm, 15 more peak-season months and 32 more off-season months on the Pit River Arm, and four more peak-season and 33 more off-season months on the Sacramento River Arm. Marinas located on the main area, McCloud River Arm, and Pit River Arm would be required to move facilities one time during four more peak-season periods and three more peak season periods on the Sacramento River Arm. Average annual use based on the 69-year hydrologic period is estimated to decrease by two percent compared to use under the No-Action Alternative.

Flatwater recreation opportunities on Lake Red Bluff (e.g. boating, water skiing, jet skiing, and swimming) that normally occur during the summer would be eliminated if the Red Bluff Diversion Dam gates are opened year-round. Two boat ramps operated by the City of Red Bluff and a water ski course would become unusable if the gates were permanently raised. Camping near Lake Red Bluff could also be affected, although most camping near the lake is associated with fishing use on the Sacramento River. The annual boat drag races during the Memorial Day weekend are the most important special event at the lake, typically attended by approximately 7,500 visitors. The races would be canceled if the gates are permanently raised. These visitors account for an estimated $500,000 to $750,000 in expenditures at local restaurants, motels, and other miscellaneous retail establishments in the City of Red Bluff.

The squawfish derby, which draws an estimated 1,000 visitors to the lake, would also be affected. Specific impacts on the event are difficult to estimate because most of the fishing use associated with the event occurs on the river below the location of the gates. However, some reduction in fishing use would be likely. The loss of recreation opportunities at Lake Red Bluff would result in eliminating local visitor spending associated with both special events and ongoing recreation. The magnitude of this impact would depend on whether current visitors continue to visit and spend recreation-related dollars in Red Bluff; however, based on current estimates of visitor spending, this impact could exceed $1 million annually. In addition, local residents who currently purchase recreation-related goods and services locally may travel elsewhere (e.g., Black Butte Reservoir, Whiskeytown Lake) for flatwater recreation opportunities, and consequently not spend as much in the local economy.

Lake Oroville boat ramps would be usable for two more peak-season months and eight more off-season months. Usable surface area for boating would be constrained for seven fewer peak-season months and ten fewer off-season months. Marinas would be required to move facilities three fewer times during the peak season. The reservoir would fall below the level at which camping and picnicking typically decline for five fewer peak-season months. Average annual use over the 69-year hydrologic period would increase by less than one percent compared to use under the No-Action Alternative.

Folsom Lake boat ramps would be usable for two more peak-season months and six fewer off-season months. Usable surface area for boating would be constrained for 10 fewer peak-season months and 16 fewer off-season months. The marina would be forced to close for 29 fewer peak season months. The reservoir would fall below the level at which camping and picnicking typically decline for 28 fewer peak-season months. Average annual use over the 69-year hydrologic period would increase by two percent compared to use under the No-Action Alternative.

At San Luis Reservoir, usable surface area for boating would be constrained for one less peak-season month and 10 fewer off-season months. Average annual use at San Luis Reservoir is estimated to increase by less than 1 percent compared to use under the No-Action Alternative.

At Millerton Lake, the frequency the reservoir would be below the levels at which recreation opportunities become constrained are the same as under the No-Action Alternative. Average annual use would not change from use estimated for the No-Action Alternative.

At New Melones Reservoir, boat ramps would be unusable for 11 more peak-season months and 13 more off-season months. Usable surface area for boating would be constrained for 13 more peak-season months. Marinas would close for 16 more peak-season months. Beach use would decline for 23 more peak-season months. The lake level would be below the level at which camping and picnicking decline for 13 more peak-season months. Average annual use is estimated to decrease by less than 1 percent compared to use under the No-Action Alternative.

Rivers

On the upper reach of Sacramento River, all boating activities would experience optimal flows for seven more peak-season months. On the lower reach, recreational opportunities are not expected to change because they are less sensitive to changes in river flows, and these flows would be similar to those under the No-Action Alternative. Compared to conditions under the No-Action Alternative, changes in the frequency when river flows are above important thresholds are not expected to result in measurable changes in recreation opportunities on the river.

American River flows would fall within the optimal range for all boating opportunities for seven fewer peak-season months and below the minimum level for 49 more peak-season months. River flows would be below the optimal swimming level for 36 more peak-season months.

For the upper reach of the San Joaquin River, river flows would be within the optimal range for canoeing during seven more peak-season months and within the optimal range for other boating activities 16 more peak-season months. River flows would be below the optimal level for swimming seven more peak-season months under Alternative 1. For the lower reach, river flows would be below the optimal level for swimming for three more peak-season months. Average annual use over the 69-year hydrologic period would be the same as under the No-Action Alternative.

For the upper reach of the Stanislaus River, river flows would fall within the optimal range for all types of boating activities during seven fewer peak-season months. For the lower reach, river flows would be within the optimal range for all boating activities 19 more peak-season months. River flows would be above the minimum level for all boating activities 58 more peak-season months. Average annual use for the entire Stanislaus River over the 69-year hydrologic period is estimated to increase by less than one percent compared to the No-Action Alternative.

Recreation opportunities and use on the Tuolumne and Mokelumne River under Alternative 1 are expected to be the same as under the No-Action Alternative. Boating and swimming opportunities would improve slightly on the Merced River. Annual use is not expected to change from use estimated under the No-Action Alternative.

Refuges and Wetlands

Visitation to Sacramento River Region wildlife refuges is expected to increased by 24 percent with waterfowl hunting increasing by 32 percent, followed by fishing use and wildlife observation both increasing by 18 percent. Visitation to San Joaquin River Region wildlife refuges is estimated to increase by 28 percent with waterfowl hunting increasing by 50 percent,

fishing use by 11 percent, and wildlife observation by 10 percent. Recreation opportunities and visitation to wildlife refuges in the Tulare Lake Region are not expected to change from conditions under the No-Action Alternative.

Waterfowl hunting opportunities on private clubs are not expected to change from conditions under the No-Action Alternative because duck clubs and other private hunting lands are expected to receive their historical water deliveries.

ALTERNATIVE 2

Reservoirs

Changes in recreation opportunities and use at CVP reservoirs, SWP reservoirs, and reservoirs operated by other agencies under Alternative 2 compared to the No-Action Alternative would be essentially the same as the changes discussed under Alternative 1.

Rivers

The changes in recreation opportunities on the Sacramento and American Rivers under Alternative 2 compared to the No-Action Alternative would be nearly the same as the changes discussed under Alternative 1.

On the upper reach of the Stanislaus River, flows would fall within the optimal range for all boating two more peak-season months. On the lower reach, flows would be within the optimal range for all boating activities 14 more peak-season months and above the minimum level for all boating activities 92 more peak-season months. Average annual use for the entire Stanislaus River is estimated to increase by one percent.

Boating opportunities would increase on the Tuolumne and Merced Rivers under Alternative 2 compared to the No-Action Alternative. Swimming opportunities would increase on the Merced River and increase slightly on the Tuolumne River. Average annual use is expected to increase slightly on the Tuolumne and Merced rivers. Recreation opportunities occurring on the Mokelumne River under Alternative 2 compared to the No-Action Alternative would be the same as described under Alternative 1.

Refuges and Wetlands

At Sacramento River Region wildlife refuges, annual visitation is expected to increase by 63 percent, with waterfowl hunting increasing by 91 percent, fishing use by 40 percent, and wildlife observation by 39 percent. At San Joaquin River Region wildlife refuges, annual visitation is expected to increase by 65 percent, with waterfowl hunting increasing by 116 percent, fishing use by 28 percent, and wildlife observation by 26 percent. Annual visitation to the Tulare Lake wildlife refuges is estimated to increase by 150 percent, with wildlife observation increasing by 149 percent and fishing use increasing by 160 percent.

Waterfowl hunting opportunities on private clubs under Alternative 2 are not expected to change from conditions under the No-Action Alternative because water deliveries from the CVP or other water sources to duck clubs and other private hunting lands would not be affected.

ALTERNATIVE 3

Reservoirs

The changes in recreation opportunities at CVP and SWP reservoirs under Alternative 3 compared to the No-Action Alternative would be nearly the same as the changes discussed under Alternative 1. Changes in recreation use at these reservoirs is estimated to range from a 2 percent increase at Folsom Reservoir to a 1 percent decrease at New Melones Reservoir.

Changes in recreation opportunities occurring at New Hogan Lake, Camanche Reservoir, and Lake McClure under Alternative 3 compared to the No-Action Alternative would be nearly the same as discussed under Alternative 1. At New Don Pedro Reservoir, boating and camping opportunities would be nearly the same as described under Alternative 1. Beach use at New Don Pedro Reservoir would decrease slightly compared to the No-Action Alternative. Recreation use under Alternative 3 would decrease slightly at New Don Pedro Reservoir and Lake McClure.

Rivers

The changes in recreation opportunities on the Sacramento, American, and San Joaquin Rivers under Alternative 3 compared to the No-Action Alternative would be nearly the same as the changes discussed under Alternative 1.

On the Stanislaus River, flows on the upper reach would fall within the optimal range for all boating activities 53 more peak-season months. On the lower reach, river flows would be within the optimal range for all boating activities 13 more peak-season months and above the minimum level for these activities 79 more peak-season months. Annual use for the entire Stanislaus River is estimated to increase by 1 percent during the 69-year hydrologic period.

Boating opportunities on the Tuolumne River and Merced River under Alternative 3 would substantially increase from conditions under the No-Action Alternative. Swimming opportunities on the Tuolumne and Merced rivers would increase compare to the No-Action Alternative. Recreation opportunities on the Mokelumne River under Alternative 3 compared to the No-Action Alternative are expected to be the same as changes described under Alternative 1. Recreation use on the Tuolumne and Merced Rivers is expected to slightly increase compared to the No-Action Alternative.

Refuges and Wetlands

The changes in recreation at wildlife refuges in the Sacramento River, San Joaquin River, and Tulare Lake regions under Alternative 3 compared to the No-Action Alternative would be the same as changes discussed under Alternative 2.

Waterfowl hunting opportunities on private clubs under Alternative 3 are not expected to change from conditions under the No-Action Alternative because duck clubs and other private hunting lands should continue to receive historical water deliveries.

ALTERNATIVE 4

Reservoirs

The changes in recreation opportunities at CVP and SWP reservoirs under Alternative 4 compared to the No-Action Alternative would be nearly the same as the changes discussed under Alternative 1. Changes in recreation use would range from a two percent increase at Shasta and Folsom Reservoirs to a one percent decrease at New Melones Reservoir.

Rivers

Changes in recreation opportunities on the Sacramento, American, and San Joaquin rivers under Alternative 4 compared to the No-Action Alternative would be nearly the same as the changes discussed under Alternative 1.

On the upper reach of the Stanislaus River, flows would fall within the optimal range for all boating 53 more peak-season months. On the lower reach, river flows would be within the optimal range for all boating activities 119 more peak-season months. Average annual use for the entire Stanislaus River is estimated to increase by 2 percent.

Boating opportunities on the Mokelumne River would decrease on the upper reach and increase on the lower reach compared to the No-Action Alternative. Swimming opportunities would increase on the Mokelumne River. On the Tuolumne and Merced rivers, changes in recreation opportunities under Alternative 4 compared to the No-Action Alternative would be nearly the same as described under Alternative 3. Average annual recreation use on the Tuolumne and Merced Rivers is estimated to increase from 3 to 8 percent over use estimated under the No-Action Alternative.

Refuges and Wetlands

The changes in recreation at wildlife refuges and private hunting clubs in the Sacramento River, San Joaquin Valley, and Tulare Lake regions under Alternative 4 compared to the No-Action Alternative would be the same as changes discussed under Alternative 2.

ALTERNATIVE 5

Reservoirs

At Shasta Lake, usable surface area for boating would be constrained for six fewer peak-season month and nine fewer off-season months on the main area of the lake, 11 fewer peak-season months and two 15 fewer off-season months on the McCloud River Arm, two fewer peak-season months and 15 more off-season months on the Pit River Arm, and 12 fewer peak-season months and 25 more off-season months on the Sacramento River Arm. Boat ramp availability would be

constrained for six fewer peak-season months and six fewer off-season months on the McCloud River Arm, two fewer peak-season months and 15 fewer off-season moths on the Pit River Arm, and six fewer peak-season months and six fewer off-season months on the Sacramento River Arm. Marinas located on the main area, McCloud River Arm, and Pit River Arm would be required to move facilities one time during one more peak-season period and on the Sacramento River Arm one time during two more peak-season periods. Annual use is estimated to increase by 2 percent over annual use estimated for the No-Action Alternative.

Changes in recreation opportunities and use at Lake Red Bluff under Alternative 5 compared to the No-Action Alternative would be the same as discussed under Alternative 1.

Lake Oroville boat ramps would be usable for 19 more peak-season months and 28 more off-season months. Usable surface area for boating would be constrained for 18 fewer peak-season months and three fewer off-season months. Marinas would be required to move facilities nine fewer times during the peak season. The reservoir would fall below the level at which camping and picnicking typically decline for 20 fewer peak-season months. Annual use would increase by less than four percent from use estimated for the No-Action Alternative.

Folsom Lake boat ramps would be usable for one more off-season month. Usable surface area for boating would be constrained for 15 fewer peak-season months and nine fewer off-season months. The marina would be forced to close for 25 fewer peak-season months. The reservoir would fall below the level at which camping and picnicking typically decline for 24 fewer peak-season months. Average annual use would increase by less than one percent over use estimated for the No-Action Alternative.

At San Luis Reservoir, usable surface area for boating would be constrained for 67 more peak-season months and 58 more off-season months. The reservoir would be below the level at which camping and picnicking decline 67 more peak-season months. Average annual use is estimated to decrease by eight percent from use estimated for the No-Action Alternative.

At Millerton Lake, usable surface area for boating would be constrained for 10 fewer peak-season months and four more off-season months. Boat ramps would be unusable for 12 more peak-season months and four more off-season months. The reservoir surface elevation would be below the level at which beach use declines for 10 fewer peak-season months. Average annual use is estimated to increase by one percent over use estimated for No-Action Alternative.

At New Melones Reservoir, boat ramps would be unusable for 40 more peak-season months and 18 more off-season months. Usable surface area for boating would be constrained for 45 more peak-season months and 18 more off-season months. Marinas would close for 72 more peak-season months. Beach use would decline for 103 more peak-season months and camping and picnicking decline for 45 more peak-season months. Average annual use is estimated to decrease by nine percent from use estimated for the No-Action Alternative.

Rivers

On the upper reach of Sacramento River, all boating activities would experience optimal flows for 77 fewer peak-season months. On the lower reach, recreational opportunities are not

expected to change because they are less sensitive to changes in river flows, and these flows would be similar to those under the No-Action Alternative.

American River flows would fall within the optimal range for all boating opportunities for 53 more peak-season months and above the minimum level for 20 more peak-season months. River flows would be above the optimal swimming level for 14 more peak-season months.

For the upper reach of the San Joaquin River, river flows would be within the optimal range for canoeing during nine more peak-season months and outside the optimal range for all other boating for 212 more peak-season months. River flows would be below the optimal level for swimming 14 more peak-season months. For the lower reach, boating and swimming opportunities would be the same as under the No-Action Alternative. Average annual use over the 69-year hydrologic period would be the same as under the No-Action Alternative.

For the upper reach of the Stanislaus River, river flows would fall within the optimal range for all types of boating activities 139 more peak-season months. For the lower reach, river flows would be within the optimal range for all boating activities 12 fewer peak-season months. River flows would be above the minimum level for all boating activities 48 more peak-season months. Annual use for the entire Stanislaus River is estimated to increase by less than 1 percent compared to the No-Action Alternative.

Boating opportunities under Alternative 5 would increase on the Tuolumne River, Calaveras River, and the lower reach of the Mokelumne River compared to the No-Action Alternative. Boating would decrease on the upper reach of the Mokelumne River. Changes in recreation opportunities on the Merced River under Alternative 5 compared to the No-Action Alternative would be nearly the same as changes described under Alternative 3. Average annual use is expected to increase on the Tuolumne and Merced Rivers compared to the No-Action Alternative.

Refuges and Wetlands

The changes in recreation at wildlife refuges and private hunting clubs in the Sacramento River, San Joaquin Valley, and Tulare Lake regions under Alternative 5 compared to the No-Action Alternative would be the same as changes discussed under Alternative 2.

RECREATION ECONOMICS

The analysis of recreation economic effects focuses on changes in recreation trip-related spending and recreation benefits. The analysis of both of these effects depends on predicted changes in recreation use, which would occur at reservoirs operated by CVP, SWP, and other water agencies; rivers and streams; federal and state wildlife refuges; private hunting clubs; and coastal waters. In this analysis, changes in recreation-related expenditures relate only to the expenditures of recreationists that occur within the region of interest. For instance, for a family from San Francisco visiting Shasta Lake, only those expenditures occurring within the Sacramento River Region would be counted. On the other hand, recreation benefits measures the

additional willingness to pay for recreation of recreationists. Since these benefits are not actual expenditures, (and thus not tied to a geographic location), all of these benefits are reported.

NO-ACTION ALTERNATIVE

Projected annual recreation-related spending levels at affected reservoirs and wildlife refuges in the Sacramento River Region under the No-Action Alternative. Projected spending includes recreation-related purchases made within the Sacramento River Region by residents of the region and by people visiting regional recreation areas who live in other regions. It excludes recreation-related purchases made outside the region by visitors in preparation for their trips or en route to regional recreation areas. The benefits of recreation activity at affected reservoirs and lakes in the Sacramento River Region are estimated to average approximately $209.1 million annually under the No-Action Alternative. Seventy-four percent of this value is associated with recreation activity at Shasta Lake.

Under the No-Action Alternative, total spending associated with use of recreation areas in the San Joaquin River Region is projected to be approximately $84 million. The benefits of recreation activity at affected reservoirs and lakes in the San Joaquin River Region are estimated to average approximately $46.2 million annually under the No-Action Alternative.

Study-area recreation sites in the Tulare Lake Region. Total recreation-related expenditures associated with use of these refuges are projected to be $77,000 under the No-Action Alternative. Recreation benefits associated with use of these refuges are estimated to be $79,200.

ALTERNATIVE 1

Under Alternative 1, annual spending associated with use of Sacramento River Region reservoirs and lakes would decline by a total of approximately $3.0 million relative to the No-Action Alternative, resulting primarily from a spending decrease of $4.3 million at Shasta Lake. Spending would increase by $1.3 million at Folsom Lake and would not change appreciably at Lake Oroville. The annual benefits of recreation activity at affected reservoirs and lakes in the Sacramento River Region are estimated to decrease by approximately $1.7 million under Alternative 1, or less than 1 percent compared to the No-Action Alternative. This overall decrease in recreation benefits reflects a $2.3 million reduction at Shasta Lake that is partially offset by increases at Folsom Lake.

Under Alternative 1, spending associated with use of New Melones Reservoir would decrease by $253,000 and spending associated with regional wildlife refuge use would increase by $662,000. Spending at all other affected recreation areas in the San Joaquin River Region would not change appreciably relative to the No-Action Alternative. Under Alternative 1, recreation benefits associated with use of New Melones Reservoir would decrease by $159,000 and benefits associated with use at regional wildlife refuges would increase by $463,000. Recreation benefits at all other affected recreation areas in the San Joaquin River Region would be unchanged compared to the No-Action Alternative.

Spending associated with use of Sacramento River Region wildlife refuges would increase by $848,000. Spending associated with waterfowl hunting opportunities on private lands would be

unchanged or decrease slightly compared to the No-Action Alternative. The benefits of recreation activity at state and federal wildlife refuges in the Sacramento River Region are estimated to increase by approximately $527,000 under Alternative 1, or about 25 percent compared to the No-Action Alternative. Recreation benefits associated with waterfowl hunting on private lands are expected to be unchanged or to decrease slightly compared to the No-Action Alternative.

No change in spending and recreation benefits associated with use of Tulare Lake Region wildlife refuges is projected under Alternative 1 as compared to No-Action Alternative. Recreation-related spending and benefits associated with waterfowl hunting on private lands are expected to be unchanged or to decrease slightly compared to the No-Action Alternative.

ALTERNATIVE 2

Under Alternative 2, recreation-related spending associated with use of Shasta Lake would decrease by approximately $3.6 million. Spending associated with use of Folsom Lake would increase by approximately $1.3 million. The annual benefits of recreation activity at affected reservoirs and lakes in the Sacramento River Region are estimated to decrease by approximately $1.3 million under Alternative 2, or less than 1 percent compared to the No-Action Alternative. This overall decrease in recreation benefits reflects a $1.9 million reduction at Shasta Lake that is partially offset by increases at Folsom Lake.

Under Alternative 2, recreation-related spending associated with use at New Melones Reservoir would decrease by $263,000. Recreation-related spending would increase by approximately $1.5 million for the region's wildlife refuges and by $28,000 for the Stanislaus River. No other recreation-related spending changes are expected in this region. The annual benefits of recreation activity at affected reservoirs and lakes in the San Joaquin River Region are estimated to decrease by approximately $164,000 under Alternative 2, or less than 1 percent compared to the No-Action Alternative. The only significant change in recreation benefits would occur at New Melones Reservoir.

The annual benefits of recreation activity at affected rivers in the San Joaquin River Region are estimated to increase by approximately $161,000 under Alternative 2 compared to the No-Action Alternative. This change represents a 4.2 percent increase in recreation benefits compared to the No-Action Alternative.

Spending associated with use at wildlife refuges would increase by $2.2 million. Spending associated with waterfowl hunting opportunities on private lands is expected to be unchanged or to decrease slightly compared to the No-Action Alternative. The benefits of recreation activity at state and federal wildlife refuges in the Sacramento River Region are estimated to increase by approximately $1.4 million under Alternative 2, or about 66 percent compared to the No-Action Alternative. Recreation benefits associated with waterfowl hunting on private lands are expected to be unchanged or to decrease slightly compared to the No-Action Alternative.

The benefits of recreation activity at state and federal wildlife refuges in the San Joaquin River Region are estimated to increase by approximately $1.1 million under Alternative 2, or about 72 percent compared to the No-Action Alternative. Recreation benefits associated with waterfowl

hunting on private lands are expected to be unchanged or to decrease slightly compared to the No-Action Alternative.

Spending associated with use of the region's wildlife refuges would increase by $116,000 under Alternative 2. Recreation benefits are estimated to increase by $119,000. Recreation-related spending and benefits associated with waterfowl hunting on private lands are expected to be unchanged or to decrease slightly compared to the No-Action Alternative.

Spending associated with waterfowl hunting opportunities on private lands is expected to be unchanged or to decrease slightly compared to the No-Action Alternative.

ALTERNATIVE 3

Under Alternative 3, spending associated with use of Shasta Lake would decrease by about $3.1 million and spending associated with use of Folsom Lake refuges would increase by approximately $1.4 million. No significant change in spending associated with use at Lake Oroville is expected. The annual benefits of recreation activity at affected reservoirs and lakes in the Sacramento River Region are estimated to decrease by approximately $1.1 million under Alternative 3, or less than 1 percent compared to the No-Action Alternative. This overall decrease in recreation benefits reflects a $1.7 million reduction at Shasta Lake that is partially offset by an increase at Folsom Lake.

Spending would decrease by $358,000 at affected reservoirs in the San Joaquin River region. Spending would increase for the Merced and Tuolumne rivers. The largest spending impact in the San Joaquin River Region under this alternative would consist of a $1.5 million increase for the wildlife refuges. Spending associated with waterfowl hunting opportunities on private lands is expected to be unchanged or to decrease slightly compared to the No-Action Alternative.

The annual benefits of recreation activity at affected reservoirs and lakes in the San Joaquin River Region are estimated to decrease by approximately $224,000 under Alternative 3, or less than 1 percent compared to the No-Action Alternative. The largest change in recreation benefits would occur at New Melones Reservoir, accounting for $127,000 in reduced benefits. The annual benefits of recreation activity at affected rivers in the San Joaquin River Region are estimated to increase by approximately $72,000 under Alternative 3. This change represents a 2 percent increase in recreation benefits compared to the No-Action Alternative.

Spending associated with use of regional wildlife refuges would be the same as described under Alternative 2. Spending and recreation benefits associated with waterfowl hunting opportunities on private lands are expected to be unchanged or to decrease slightly compared to the No-Action Alternative.

ALTERNATIVE 4

Among the region's reservoirs, spending would decrease by $2.1 million at Shasta Lake and would increase by $1.3 million at Folsom Lake. Spending would also increase by $2.2 million at the region's wildlife refuges. Spending associated with waterfowl hunting opportunities on private lands is expected to be unchanged or to decrease slightly compared to the No-Action

Alternative. The annual benefits of recreation activity at affected reservoirs and lakes in the Sacramento River Region are estimated to decrease by approximately $517,000 under Alternative 4, or less than 1 percent compared to the No-Action Alternative. This overall decrease in recreation benefits reflects a $1.1 million reduction at Shasta Lake that is partially offset by increases at Folsom Lake.

Overall spending at San Joaquin River Region reservoirs and lakes is estimated to decrease by $98,000. Spending associated with use of all of the region's rivers except the San Joaquin River would increase. In total, spending at San Joaquin River Region rivers would increase by $196,000.

The annual benefits of recreation activity at affected reservoirs and lakes in the San Joaquin River Region are estimated to decrease by approximately $58,000 under Alternative 4, or less than 1 percent compared to the No-Action Alternative. The annual benefits of recreation activity at affected rivers in the San Joaquin River Region are estimated to increase by approximately $94,000 under Alternative 4. This change represents a 2 percent increase in recreation benefits compared to the No-Action Alternative.

Spending associated with use of regional wildlife refuges would be the same as described under Alternative 2. Spending and recreation benefits associated with waterfowl hunting opportunities on private lands are expected to be unchanged or to decrease slightly compared to the No-Action Alternative.

ALTERNATIVE 5

Reservoir-related spending would increase by $4.8 million in the Sacramento River Region under Alternative 5. An increase in spending at Shasta Lake would be partially offset by a decrease at Lake Oroville. The annual benefits of recreation activity at affected reservoirs and lakes in the Sacramento River Region are estimated to increase by approximately $3.2 million under Alternative 5, or by 1.5 percent compared to the No-Action Alternative. This overall increase in recreation benefits reflects a $3.2 million increase at Shasta Lake that is partially offset by a decrease at Lake Oroville.

The annual benefits of recreation activity at affected reservoirs and lakes in the San Joaquin River Region are estimated to decrease by approximately $2.4 million (about 5 percent) under Alternative 5, compared to the No-Action Alternative. The largest changes in recreation benefits would occur at New Melones Reservoir (accounting for $954,000 in reduced benefits). The annual benefits of recreation activity at affected rivers in the San Joaquin River Region are estimated to increase by approximately $270,000 under Alternative 5. This change represents a 7 percent increase in recreation benefits compared to the No-Action Alternative.

Spending associated with use of regional wildlife refuges would be the same as described under Alternative 2. Spending associated with waterfowl hunting opportunities on private lands is expected to decrease compared to the No-Action Alternative. No estimates were made of the level of this decrease.

REGIONAL ECONOMICS

The principal water-using categories of direct impacts are expected to be agricultural production, recreation, municipal and industrial use, and power production. The incremental impact results, estimated by the other economic analysis tools, are input into the regional economics analysis as the change caused by each alternative as compared to the No-Action Alternative. There is no impact analysis for unit price per fish because there are no estimates of fish catch for the alternatives. Rather, there is an estimate of changes in fishing use for streams, reservoirs, and refuges associated with the quality of the fishing experience.

Direct economic impacts of the alternatives have been measured for activities occurring throughout California. Since the actual incidence of these direct impacts may be distributed across locations throughout the study area, secondary impacts related to the direct impacts may occur in some parts of the area and not others. To better reflect these differences, multi-county regions are identified.

Regional input-output models have been utilized to measure the indirect impacts associated with estimated direct impacts. Models have been estimated for seven subregions in California. Each model follows county lines and incorporates, to the extent allowed by available data, the distinct sectoral characteristics of the region modeled. All changes are assumed to be average annual changes.

NO-ACTION ALTERNATIVE

The regional economic analysis does not include a No-Action Alternative condition as presented in the other PEIS issue areas. This is because there are no regional economic data available for the 2020 condition, and there is no way to predict the size or structure of the regional economy as it might exist in the future at a 2020 level of development. Therefore, the PEIS regional economic analysis uses the 1991 IMPLAN database as the baseline condition. It is implicitly assumed that the structure of the California economy and the technical relationships and production processes incorporated into the models will be valid at a 2020 level of development.

Input-output models such as IMPLAN are independent of the scale of the regional economy. The method assumes constant returns to scale, and the structure of the regional economy does not change with respect to scale. If the regional economy doubles in size, the dollar or employment impacts of a dollar change in final demand are the same. However, the impact as a share of the size of the doubled economy will be one-half of the same impact as a share of the baseline economy.

Structural economic change would require consideration of how shares of economic activity, as opposed to the size of the economy, change over time. Changes in technology, trade patterns and relative prices change regional economic structure in ways that cannot be predicted by input-output, and no attempt has been made to account for structural change in the IMPLAN models.

Nonetheless, a few generalizations are possible. First, economic activity has become more integrated across regions over time. Small economic regions become relatively less independent over time as a larger share of trade is conducted outside of the region. This tends to reduce

regional economic multipliers because there is more leakage to the outside economy. Second, Central Valley agriculture has become a smaller component of the economy of the entire region, and this may be expected to continue as growth in non-agricultural industries continues. Third, economic trends that have affected the nation as a whole may be expected to continue. These trends include a relatively fast rate of growth in service industries and in labor-intensive research and development "high-tech" industries, and a relative decline in heavy manufacturing, mining, and agriculture.

The changes in regional economic activity between the alternatives and the No-Action Alternative are based on the changes in direct economic activity. These changes are estimated by each of the economic analysis tools and then input into IMPLAN. Each of the tools has a No-Action Alternative simulation to allow the estimate of direct changes at the 2020 level of development. These direct changes, relative to the No-Action Alternative, are then used within IMPLAN to estimate secondary economic impacts.

Some IMPLAN results are also presented in terms of percent of the baseline levels, to provide the reader with a reference for magnitude of change. These results are presented for comparison purposes only and must be qualified by noting that baseline levels may change between 1991 and 2020.

ALTERNATIVE 1

The largest total impacts (sum of direct, indirect, and induced) in California occur in the agricultural sector. The impacts are the result of both land fallowing and higher water costs. The next largest impacts, in the trade sector, are the result of reduced spending by farmers for production inputs and household items; lower recreational spending; and lower spending on non-water items by all households that must pay higher water costs.

Sacramento River Region

Alternative 1 results in a minor change in agricultural activity in the Sacramento River Region, relative to baseline levels in the No-Action Alternative. Total regional impacts due to Alternative 1 changes in agriculture include direct losses of about 50 jobs, $3,500,000 in output, and $1,400,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of about 130 jobs, $8,700,000 in output, and $4,300,00 in place-of-work income.

Alternative 1 results in approximately a one-percent decline in recreational spending relative to baseline conditions. The resultant changes in final demands, relative to the No-Action Alternative, cause the loss of about 100 jobs, $4,300,000 in output, and $2,700,000 in place-of-work income.

The resultant declines in consumer spending cause direct losses of about 50 jobs, $3,600,000 in output, and $2,000,000 in place-of-work income. Total impacts include losses of about 100 jobs, $7,500,000 in output, and $4,300,000 in place-of-work income.

Total direct, indirect, and induced impacts of Alternative 1 relative to the No-Action Alternative include losses of about 340 jobs, $20,500,000 in output, and $11,300,000 in place-of-work

income. Total direct, indirect, and induced impacts represent 0.027 percent, 0.026 percent, and 0.024 percent of the baseline values of the respective variables. The greatest total regional effects on employment and output are attributable to the direct impacts on agriculture; the greatest effects on place-of-work income are attributable to municipal water costs.

The largest employment and income impacts are in trade. The largest output impacts are in services. Land fallowing and reduced net farm income cause reduced spending for production inputs and household items, with attendant effects on the trade and services sectors. Reduced recreation expenditures and higher municipal water costs affect the trade and service sectors as well.

San Joaquin River Region

Total regional impacts due to Alternative 1 changes in agriculture include direct losses of about 945 jobs, $78,100,000 in output, and $28,900,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of 2,372 jobs, $160,900,000 in output, and $74,400,000 in place-of-work income.

Alternative 1 results in approximately a one-percent increase in recreational spending relative to baseline conditions. Total impacts include gains of more than 10 jobs, $600,000 in output, and $400,000 in place-of-work income.

Alternative 1 results in reduced personal income of $5,100,000 per year because of higher municipal water costs, due primarily to household metering costs and restoration payments. The resultant declines in consumer spending cause direct losses of about 70 jobs, $4,900,000 in output, and $2,700,000 in place-of-work income. Total impacts include losses of about 140 jobs, $8,800,000 in output, and $5,000,000 in place-of-work income.

Total direct, indirect, and induced impacts include losses of about 2,500 jobs, $169,100,000 in output, and $79,100,000 in place-of-work income compared to the No-Action Alternative. The total impacts represent 0.28 percent, 0.28 percent, and 0.26 percent of the baseline values of employment, output and place-of-work income, respectively.

The largest employment impacts are in agriculture, trade, and services. The largest output impacts are in agriculture, manufacturing, and finance, insurance, and real estate (FIRE). The largest income impacts are in FIRE, trade, and services. Land fallowing and reduced net farm income cause reduced spending for production inputs and household items, with attendant effects on the manufacturing, FIRE, and trade and services sectors. Reduced recreation expenditures and higher municipal water costs affect the trade and service sectors as well.

Tulare Lake Region

Total regional impacts due to Alternative 1 changes in agriculture, relative to the No-Action Alternative, include direct losses of about 430 jobs, $30,300,000 in output, and $11,300,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of about 940 jobs, $59,600,000 in output, and $27,100,000 in place-of-work income.

Alternative 1 causes no impacts on recreational spending relative to the No-Action Alternative. Alternative 1 also causes no impacts on municipal and industrial water costs in the Tulare Lake Region, relative to No-Action Alternative. Therefore, total direct impacts are the same as those shown for Agriculture. Total direct, indirect, and induced impacts represent 0.18 percent, 0.19 percent, and 0.18 percent of the baseline values of employment, output and place-of-work income, respectively.

The largest employment impacts are in agriculture, trade, and services. The largest output impacts are in agriculture, trade, and manufacturing. The largest income impacts are in trade, agriculture, and FIRE. Land fallowing and reduced net farm income cause reduced spending for production inputs and household items, with attendant effects on the trade and services sectors. Other impacts are attributable primarily to those originating in agriculture.

North Coast Region

Alternative 1 causes no impacts in the North Coast Region relative to the No-Action Alternative.

South Coast Region

Alternative 1 causes no impacts on recreational spending relative to the No-Action Alternative. Alternative 1 results in greater deliveries of SWP water for municipal purposes in the South Coast Region. Municipal water costs decline, and discretionary income available for non-water purchases increases by $31,790,000 per year. The resultant increases in consumer spending cause direct gains of about 410 jobs, $30,600,000 in output, and $16,300,000 in place-of-work income. Total impacts include gains of about 960 jobs, $69,600,000 in output, and $38,900,000 in place-of-work income.

San Francisco Bay Region

Alternative 1 results in reduced personal income of $3,700,000 per year in the San Francisco Bay Region because of higher water costs, due primarily to restoration payments. The resultant declines in consumer spending cause direct losses of about 40 jobs, $3,600,000 in output, and $1,900,000 in place-of-work income. Total impacts include losses of about 100 jobs, $7,500,000 in output, and $4,300,000 in place-of-work income.

Total Impacts

Total direct impacts across all impacted regions in California, relative to the No-Action Alternative, include losses of over 1,220 jobs, $94,900,000 in output, and $32,600,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of about 2,920 jobs, $187,500,000 in output, and $82,800,000 in place-of-work income. The total impacts represent 0.002 percent, 0.005 percent, and 0.001 percent of the baseline values of employment, output and place-of-work income, respectively. Total regional job losses due to agricultural impacts include about 2,160 due to fallowed land and 1,290 due to reduced net income. Those losses are offset in part by the positive effects of increased municipal deliveries and resultant job gains in the South Coast Region.

ALTERNATIVE 2

Sacramento River Region

Alternative 2 also results in approximately a 0.4 percent decline in recreational spending relative to baseline conditions. The resultant changes in final demands cause direct losses in the impacted retail and service sectors of about 20 jobs, $700,000 in output, and $500,000 in place-of-work income. Total impacts include losses of about 40 jobs, $1,800,000 in output, and $1,200,000 in place-of-work income.

The losses attributable to the impacts of Alternative 2 on municipal water costs are the same as Alternative 1.

Total direct impacts of Alternative 2, relative to the No-Action Alternative, include losses of about 200 jobs, $14,100,000 in output, and $5,300,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of about 530 jobs, $34,900,000 in output, and $17,100,000 in place-of-work income. The total impacts represent 0.041 percent, 0.044 percent, and 0.036 percent of the baseline values of employment, output and place-of-work income, respectively. The greatest total regional effects on employment, output, and income are attributable to the direct impacts on agriculture.

The largest employment and income impacts are in services. The largest output impacts are in manufacturing. Reduced rice output and lower net farm income cause reduced output by the rice milling sector and lower demands for production inputs. Reduced recreation expenditures and higher municipal water costs also affect the trade and services sectors.

San Joaquin River Region

Total regional impacts due to Alternative 2 changes in agriculture include direct losses of about 1,100 jobs, $91,700,000 in output, and $29,600,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of about 2,920 jobs, $197,400,000 in output, and $87,100,000 in place-of-work income.

Alternative 2 results in approximately a three percent increase in recreational spending relative to baseline conditions. The resultant changes in final demands, relative to the No-Action Alternative, cause direct gains in the impacted retail and service sectors of about 20 jobs, $700,000 in output, and $400,000 in place-of-work income. Total impacts include gains of about 40 jobs, $1,600,000 in output, and $1,000,000 in place-of-work income.

The losses attributable to the impacts of Alternative 2 on municipal water costs are the same as Alternative 1.

Total direct impacts of Alternative 2, relative to the No-Action Alternative, include losses of about 1,150 jobs, $95,800,000 in output, and $31,700,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of about 3,030 jobs, $204,600,000 in output, and $91,200,000 in place-of-work income. The total impacts represent 0.34 percent, 0.34 percent,

and 0.30 percent of the baseline values of the employment, output and place-of-work income, respectively.

The largest employment impacts are in agriculture, trade, and services. The largest output impacts are in agriculture, manufacturing, and FIRE. The largest income impacts are in FIRE, agriculture, and services.

Tulare Lake Region

Total regional impacts caused by direct changes to agriculture in Alternative 2 include direct losses of about 400 jobs, $28,100,000 in output, and $10,400,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of about 880 jobs, $55,400,000 in output, and $25,000,000 in place-of-work income.

Alternative 2 causes a 53 percent increase in recreational spending relative to baseline conditions, from $34,000 to $52,000. While the percentage gain is large, the absolute gain is modest. Direct gains include increases of two jobs and small increments in both output and place-of-work income. Total impacts include gains of less than 10 jobs and approximately $100,000 in both regional output and place-of-work income.

Alternative 2 causes no impacts on municipal and industrial water costs in the Tulare Lake Region.

Total direct impacts of Alternative 2 on the Tulare Lake Region, relative to the No-Action Alternative, include direct losses of about 400 jobs, $28,100,000 in output, and $10,400,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of about 870 jobs, $55,300,000 in output, and $24,900,000 in place-of-work income. The total impacts represent 0.17 percent, 0.18 percent, and 0.17 percent of the baseline values of employment, output and place-of-work income, respectively.

The largest employment impacts are in agriculture, trade, and services. The largest output impacts are in agriculture, trade, and manufacturing. The largest income impacts are in trade, agriculture, and FIRE. Land fallowing and reduced net farm income cause reduced spending for production inputs and household items, with attendant effects on the trade and services sectors. Other impacts are attributable primarily to those originating in agriculture.

North Coast Region

Alternative 2 causes no impacts in the North Coast Region relative to the No-Action Alternative.

Central Coast Region

Alternative 2 causes no impacts in the Central Coast Region relative to the No-Action Alternative.

South Coast Region

Alternative 2 results in greater deliveries of SWP water for municipal purposes in the South Coast Region. The impacts are the same as those for Alternative 1.

San Francisco Bay Region

Alternative 2 results in higher municipal water costs for the San Francisco Bay Region. The impacts are the same as those for Alternative 1.

Total Impacts

The total direct impacts of Alternative 2 across all impacted regions in California, relative to the No-Action Alternative, include losses of about 1,370 jobs, $111,300,000 in output, and $33,000,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of about 3,560 jobs, $233,100,000 in output, and $98,500,000 in place-of-work income. The total impacts represent 0.002 percent, 0.006 percent, and 0.001 percent of the baseline values of employment, output and place-of-work income, respectively.

ALTERNATIVE 3

Sacramento River Region

Total regional impacts due to Alternative 3 changes in agriculture, relative to the No-Action Alternative, include direct losses of about 110 jobs, $9,700,000 in output, and $2,800,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of about 370 jobs, $25,400,000 in output, and $11,600,00 in place-of-work income.

Alternative 3 results in approximately a 0.3 percent decline in recreational spending relative to baseline conditions. The resultant changes in final demands, relative to the No-Action Alternative, cause direct losses in the impacted retail and service sectors of about 15 jobs, $500,000 in output, and $400,000 in place-of-work income. Total impacts include losses of about 30 jobs, $1,200,000 in output, and $800,000 in place-of-work income.

The losses attributable to the impacts of Alternative 3 on municipal water costs are the same as discussed under Alternative 1.

Total direct impacts of Alternative 3, relative to the No-Action Alternative, include losses of about 180 jobs, $13,800,000 in output, and $5,200,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of about 500 jobs, $34,100,000 in output, and $16,700,000 in place-of-work income. The total impacts represent 0.039 percent, 0.043 percent, and 0.035 percent of the baseline values of employment, output and place-of-work income respectively. The greatest total regional effects on employment, output, and income are attributable to the direct impacts on agriculture.

The largest employment and income impacts are in services. The largest output impacts are in manufacturing. Reduced rice output and lower net farm income cause reduced output by the rice

milling sector and lower demands for production inputs. Reduced recreation expenditures and higher municipal water costs also affect the trade and services sectors.

San Joaquin River Region

Total regional impacts due to Alternative 3 changes, relative to the No-Action Alternative, in agriculture include direct losses of about 240 jobs and $41,100,000 in output, but a gain of $30,900,000 in place-of-work income. The income gain is due to the impacts of increased water sales on trade employment. Total direct, indirect, and induced impacts include losses of about 2,430 jobs, $167,500,000 in output, and $33,300,000 in place-of-work income. While direct place-of-work income impacts are positive, total place-of-work income impacts are negative because of the large effects of fallowed acreage on manufacturing, trade, and service sectors.

The gains attributable to the impacts of Alternative 3 on recreation are the same as discussed under Alternative 2.

The losses attributable to the impacts of Alternative 3 on municipal water costs are the same as discussed under Alternative 1.

Total direct impacts of Alternative 3, relative to the No-Action Alternative, include losses of about 290 jobs, $45,200,000 in output, and a gain of $28,700,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of about 2,540 jobs, $174,800,000 in output, and $37,300,000 in place-of-work income. The total impacts represent 0.28 percent, 0.29 percent, and 0.123 percent of the baseline values of employment, output and place-of-work income respectively.

The largest employment impacts are in increases in agriculture, trade, and manufacturing. The largest output impacts are a decrease in agriculture, an increase in trade, and a decrease in FIRE. The largest income impacts are a decrease in agriculture, an increase in trade, and a decrease in FIRE.

Tulare Lake Region

Total regional impacts due to Alternative 3 changes in agriculture include direct losses of 384 jobs, $27,800,000 in output, and $10,300,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of 859 jobs, $54,800,000 in output, and $24,700,000 in place-of-work income.

The recreational gains attributable to Alternative 3 are the same as those discussed under Alternative 2.

Alternative 3 causes no impacts on municipal and industrial water costs in the Tulare Lake Region.

Total direct impacts of Alternative 3 on the Tulare Lake Region, relative to the No-Action Alternative, include direct losses of 382 jobs, $27,800,000 in output, and $10,300,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of 856 jobs,

$54,700,000 in output, and $24,600,000 in place-of-work income. The total impacts represent 0.17 percent, 0.18 percent, and 0.17 percent of the baseline values of the respective variables.

The largest employment and output impacts are in agriculture. The largest income impacts are in trade. Land fallowing and reduced net farm income cause reduced spending for production inputs and household items, with attendant effects on the trade and services sectors. Other impacts are attributable primarily to those originating in agriculture.

North Coast Region

Alternative 3 causes no impacts in the North Coast Region relative to the No-Action Alternative.

Central Coast Region

Alternative 3 causes no impacts in the Central Coast Region relative to the No-Action Alternative.

South Coast Region

Alternative 3 results in greater deliveries of SWP water for municipal purposes in the South Coast Region. Municipal water costs decline, and discretionary income available for non-water purchases increases by $39,680,000 per year. The resultant increases in consumer spending cause direct gains of about 510 jobs, $38,200,000 in output, and $20,400,000 in place-of-work income. Total impacts include gains of about 1,200 jobs, $86,800,000 in output, and $48,600,000 in place-of-work income.

San Francisco Bay Region

Alternative 3 results in higher municipal water costs for the San Francisco Bay Region. The impacts are the same as those discussed under Alternative 1.

Total Impacts

The total direct impacts of Alternative 3 across all impacted regions in California, relative to the No-Action Alternative, include losses of about 380 jobs and $52,300,000 in output, and a gain of $31,600,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of about 2,800 jobs, $184,200,000 in output, and $34,300,000 in place-of-work income. The total impacts represent 0.002 percent, 0.005 percent, and 0.001 percent of the baseline values of the respective variables.

The direct place-of-work income impacts are positive, while the total place-of-work income impacts are negative because of the relative magnitudes of the multipliers for fallowed land, higher water costs, and increased water sales. The multiplier for fallowed land (reduced output) is 3.3 for the specific combination of crop acres idled under this Alternative. The multiplier for income from water sales is 1.8. Hence, every $1.00 in reduced output from fallowed land causes a $3.30 dollar decline in total regional output across all sectors. Every $1.00 in increased income from water sales causes a $1.80 increase in total regional output. As a result, while the direct

negative impacts of fallowed land do not outweigh the direct positive impacts of water sales, the total negative impacts from fallowed land more than offset the total positive impacts from water sales.

ALTERNATIVE 4

Sacramento River Region

Total regional impacts due to Alternative 4 changes in agriculture include direct losses of about 310 jobs, $26,300,000 in output, and $4,500,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of about 1,170 jobs, $77,900,000 in output, and $33,100,00 in place-of-work income.

Alternative 4 results in a slight increase in recreational spending relative to No-Action Alternative. Spending in some of the affected retail sectors increase, while that in others declines. The resultant changes in final demands cause small increases in employment, output, and place-of-work income.

The losses attributable to the impacts of Alternative 4 on municipal water costs are the same as those discussed under Alternative 1.

Total direct impacts of Alternative 4 include losses of about 370 jobs, $29,900,000 in output, and $6,500,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of about 1,280 jobs, $85,300,000 in output, and $37,400,000 in place-of-work income. The total impacts represent 0.098 percent, 0.108 percent, and 0.078 percent of the baseline values of the respective variables. The greatest total regional effects on employment, output, and income are attributable to the direct impacts on agriculture.

The largest employment and output impacts are in agriculture. The largest income impacts are in FIRE.

San Joaquin River Region

Total regional impacts due to Alternative 4 changes in agriculture include direct losses of about 370 jobs and $51,200,000 in output, but a gain of $30,300,000 in place-of-work income. The income gain is due to the impacts of increased water sales on trade employment. Total direct, indirect, and induced impacts include losses of about 2,860 jobs, $195,100,000 in output, and $43,000,000 in place-of-work income. While direct place-of-work income impacts are positive, total place-of-work income impacts are negative because of the large effects of fallowed acreage on manufacturing, trade, and service sectors.

Alternative 4 causes a 3 percent increase in recreational spending relative to baseline conditions. The resultant changes in final demands, relative to the No-Action Alternative, cause direct gains in the impacted retail and service sectors of about 30 jobs, $800,000 in output, and $500,000 in place-of-work income. Total impacts include gains of about 40 jobs, $1,800,000 in output, and $1,100,000 in place-of-work income.

The losses attributable to the impacts of Alternative 4 on municipal water costs are the same as those discussed under Alternative 1.

Total direct impacts of Alternative 4, relative to the No-Action Alternative, include losses of 419 jobs, $55,300,000 in output, and a gain of $28,200,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of 2,956 jobs, $202,100,000 in output, and $46,900,000 in place-of-work income. The total impacts represent 1.30 percent, 1.61 percent, and 0.31 percent of the baseline values of the respective variables. The largest employment, output, and income impacts are in agriculture.

Tulare Lake Region

The total impacts from the effects of Alternative 4 on agriculture are approximately equal to those for Alternative 3. Total regional impacts include direct losses of about 380 jobs, $27,600,000 in output, and $10,100,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of about 850 jobs, $54,400,000 in output, and $24,500,000 in place-of-work income.

The recreational gains attributable to Alternative 4 are the same as those discussed under Alternative 1.

Alternative 4 causes no impacts on municipal and industrial water costs in the Tulare Lake Region.

Total direct impacts of Alternative 4 on the Tulare Lake Region, relative to the No-Action Alternative, include direct losses of about 380 jobs, $27,600,000 in output, and $10,100,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of about 850 jobs, $54,300,000 in output, and $24,400,000 in place-of-work income. The total impacts represent 0.17 percent, 0.18 percent, and 0.17 percent of the baseline values of the respective variables.

The largest employment and output impacts are in agriculture. The largest income impacts are in trade. Land fallowing and reduced net farm income cause reduced spending for production inputs and household items, with attendant effects on the trade and services sectors. Other impacts are attributable primarily to those originating in agriculture.

North Coast Region

Alternative 4 causes no impacts in the North Coast Region relative to the No-Action Alternative.

Central Coast Region

Alternative 4 causes no impacts in the Central Coast Region relative to the No-Action Alternative.

South Coast Region

Alternative 4 results in lower municipal water costs for the South Coast Region. The impacts are the same as Alternative 3.

San Francisco Bay Region

Alternative 4 results in higher municipal water costs for the San Francisco Bay Region. The impacts are the same as those discussed under Alternative 1.

Total Impacts

The total direct impacts of Alternative 4 across all impacted regions in California, relative to the No-Action Alternative, include losses of about 700 jobs and $78,200,000 in output, and a gain of $30,000,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of about 4,000 jobs, $262,400,000 in output, and $64,400,000 in place-of-work income. The total impacts represent 0.003 percent, 0.007 percent, and 0.002 percent of the baseline values of the respective variables.

The direct place-of-work income impacts are positive, while the total place-of-work income impacts are negative. The difference arises for the same reasons as discussed for Alternative 3.

ALTERNATIVE 5

Because the projected direct impacts are so large in virtually all sectors, impact estimation using static input-output models is doubtful. Implementation of Alternative 5 would cause changes in the structure of the entire California economy, and the technical relationships and production processes incorporated in the estimated models would certainly change by 2020. Consequently, the impacts presented should be viewed with caution and are not strictly comparable with impacts for the other alternatives.

Sacramento River Region

Total regional impacts due to Alternative 5 changes in agriculture include direct losses of about 310 jobs, $26,300,000 in output, and $4,500,000 in place-of-work income. Total direct, indirect, and induced impacts include losses of about 1,170 jobs, $77,900,000 in output, and $33,100,00 in place-of-work income.

Alternative 5 results in increases in recreational spending relative to the No-Action Alternative. Spending in of the affected retail sectors increases $3,268,000. The resultant changes in final demands cause direct increases of about 110 jobs, $3,500,000 in output, and $2,400,000 in place-of-work income. Total direct, indirect, and induced impacts include gains of about 210 jobs, $9,500,000 in output, and $6,000,000 in place-of-work income.

Alternative 5 results in reduced personal income of $3,350,000 per year because of higher municipal water costs, as compared to $3,820,000 for Alternatives 1 through 4. The resultant decline in consumer spending cause direct losses of about 50 jobs, $3,200,000 in output, and

$1,700,000 in place-of-work income. Total impacts include losses of about 100 jobs, $6,600,000 in output, and $3,800,000 in place-of-work income.

Total direct impacts of Alternative 5, relative to the No-Action Alternative, include gains of about 3,350 jobs and $257,100,000 in place-of-work income, but a loss of $214,900,000 in output. Total direct, indirect, and induced impacts include losses of about 10,400 jobs, $1,056,800,000 in output, and $162,500,000 in place-of-work income. The total impacts represent 0.803 percent, 1.302 percent, and 0.344 percent of the baseline values of the respective variables. The greatest total regional effects on employment, output, and income are attributable to the direct impacts on agriculture.

San Joaquin River Region

Total regional impacts due to Alternative 5 changes in agriculture include direct gains of about 2,180 jobs and $267,600,000 in place-of-work income, but a loss of $194,100,000 in output. The employment and income gains are due to the impacts of increased water sales on trade employment. Total direct, indirect, and induced impacts include losses of about 11,400 jobs, $973,200,000 in output, and $108,900,000 in place-of-work income.

While direct place-of-work income impacts are positive, total place-of-work income impacts are negative because of the large effects of fallowed acreage on manufacturing, trade, and service sectors.

Alternative 5 causes a 1.5 percent decline in recreational spending relative to baseline conditions. The resultant changes in final demands, relative to the No-Action Alternative, cause direct losses in the impacted retail and service sectors of about 10 jobs, $400,000 in output, and $300,000 in place-of-work income. Total impacts include gains of about 20 jobs, $800,000 in output, and $500,000 in place-of-work income.

Alternative 5 results in reduced personal income of $4,410,000 per year because of higher municipal water costs (compared to $5,100,000 for Alternative 1-4). The resultant declines in consumer spending cause direct losses of about 60 jobs, $4,200,000 in output, and $2,300,000 in place-of-work income. Total impacts include about 120 jobs, $7,600,000 in output, and $4,300,000 in place-of-work income.

Total direct impacts of Alternative 5 include gains of about 2,100 jobs and $265,000,000 in place-of-work income, but a loss of $198,700,000 in output. Total direct, indirect, and induced impacts include losses of about 11,530 jobs, $981,600,000 in output, and $113,700,000 in place-of-work income. The total, and induced represent 1.30 percent, 1.61 percent, and 0.37 percent of the baseline values of the respective variables. The largest employment, output, and income impacts are in agriculture.

Tulare Lake Region

Total regional impacts due to Alternative 5 changes in agriculture include direct gains of 1,997 jobs, $69,400,000 in output, and $146,700,000 in place-of-work income. All the gains are due to the relatively larger gains from water sales offsetting losses from fallowed land and higher water

costs. Total direct, indirect, and induced impacts include losses of about 1,330 jobs and $87,000,000 in output, but a gain of $77,600,000 in place-of-work income.

The recreational gains attributable to Alternative 5 are the same as those discussed under Alternative 2.

Alternative 5 causes no impacts on municipal and industrial water costs in the Tulare Lake Region.

Total direct impacts of Alternative 5, relative to the No-Action Alternative, are almost identical to those for agriculture above. The total impacts represent 0.28 percent, 0.28 percent, and 0.50 percent of the baseline values of the respective variables. The largest employment, output and income impacts are in agriculture.

North Coast Region

Alternative 5 causes no impacts in the North Coast Region relative to the No-Action Alternative.

Central Coast Region

Alternative 5 causes no impacts in the Central Coast Region relative to the No-Action Alternative.

South Coast Region

Alternative 5 causes no impacts on municipal water costs relative to the No-Action Alternative.

San Francisco Bay Region

Alternative 5 results in reduced personal income of $2,490,000 per year because of higher municipal water costs. The resultant declines in consumer spending cause direct losses of about 30 jobs, $2,400,000 in output, and $1,300,000 in place-of-work income. Total impacts include losses of about 70 jobs, $5,000,000 in output, and $2,900,000 in place-of-work income.

Total Impacts

The total direct impacts of Alternative 5 across all impacted regions in California, relative to the No-Action Alternative, include gains of about 7,430 jobs and $667,500,000 in place-of-work income, and a loss of $346,700,000 in output. Total direct, indirect, and induced impacts include losses of about 23,340 jobs, $2,130,400,000 in output, and $201,400,000 in place-of-work income. The total impacts represent 0.14 percent, 0.18 percent, and 0.03 percent of the baseline values of the respective variables.

VEGETATION AND WILDLIFE

Impacts to vegetation and wildlife can result from changes in land uses, agricultural practices, and operation of water delivery systems. This impact analysis focuses on changes in habitat rather than on changes in population sizes of individual species. Population sizes have not been evaluated because they can be affected by a variety of uncontrollable factors, such as the condition of waterfowl breeding habitat in Canada, and because consistent population models are not available for all species in all affected areas.

Three general categories of habitats are considered: natural terrestrial and agricultural habitats, wetland and riparian habitats, and river and reservoir habitats. In general, natural habitats provide more value to wildlife than agricultural habitats. Agricultural habitats are ranked in order of their importance to wildlife. Detailed cause-and-effect relationships are not evaluated. Rather, data from existing models are used to evaluate general relationships and trends.

The following assumptions about land use were used in the analysis:

- No increase in urban development beyond the amount in the No-Action Alternative will occur under any alternative.
- No currently uncultivated land will be put into agricultural development.

NO-ACTION ALTERNATIVE

Natural and Agricultural Communities

Under the No-Action Alternative, the riparian areas along the Sacramento, Feather, American, Merced, Tuolumne, Stanislaus, and San Joaquin rivers would be similar to those described under the Affected Environment of the Vegetation and Wildlife Technical Appendix. The abundance and distribution of common riparian plant species (e.g., willows, Fremont cottonwood, western sycamore, bigleaf maple, Oregon ash, and white alder), common wildlife species that use riparian habitats (e.g., northern flicker, scrub jay, American goldfinch, rufus-sided towhee, plain titmouse, and ground squirrel), and the availability of fish as prey for belted kingfishers, river otter, and other wildlife associated with riverine habitats would also be similar.

Rivers and Reservoirs

The drawdown zone of Folsom Lake supports willow scrub in the 400-to 470-foot elevation range. Under the No-Action Alternative, water levels would vary from approximately 418 to 448 feet during March through August (lowest in March and August, highest in April). Water levels would exceed 400 feet (low in the riparian zone) for more than three months in approximately 94 percent of years and 440 feet (high in the riparian zone) for more than three months in approximately 39 percent of years. The extent of riparian vegetation would probably be reduced due to inundation-induced mortality, which would have minimal effects on common riparian plant species and wildlife species using riparian habitats, because only a small area of riparian habitat would be affected.

For Shasta, Lake Oroville, Folsom, and Whiskeytown lakes, the proportion of shallow water (less than 1 foot deep) used by mallards and cinnamon teal, deep water habitat (from 1 to 15 feet deep) used by lesser scaup and ring-necked duck, and open water habitat (more than 15 feet deep) used by gulls and western grebe would be similar to those conditions described under the Affected Environment section of the Vegetation and Wildlife Technical Appendix. Shallow water habitat provides the least habitat, while open water habitat provides the most habitat. No changes would occur in the smaller and shallower regulating reservoirs associated with each large reservoir, that generally receive more use by waterbirds.

For New Don Pedro, New Melones, and Camanche reservoirs, and Lake McClure, and Millerton and New Hogan lakes, the proportion of shallow water habitat (less than 1 foot deep) used by mallards and cinnamon teal, deep water habitat (from 1 to 15 feet deep) used by lesser scaup and ring-necked duck, and open water habitat (more than 15 feet deep) used by gulls and western grebe would be similar to those conditions described under the Affected Environment section of the Vegetation and Wildlife Technical Appendix. Shallow water habitat provides the least habitat, while open water habitat provides the most habitat. No changes would occur in the smaller and shallower regulating reservoirs associated with each large reservoir, that generally receive more use by waterbirds.

Waterfowl and Shorebirds

The Sacramento Valley refuges, including Sacramento NWR, Delevan NWR, Colusa NWR, Sutter NWR, and Gray Lodge WMA, provide approximately 2,450 acres of permanent ponds, 14,650 acres of seasonal marshes, and 1,900 acres of watergrass (millet). These habitats were managed for migratory and breeding waterfowl and other wetland-dependent wildlife at Sacramento Valley refuges. Water supplies available to refuges under the No-Action Alternative would limit the flexibility of refuge managers to use adaptive management techniques to adjust the timing and locations of wetland habitats to maximize their benefits to wildlife.

Wetlands available on San Joaquin Valley refuges (excluding the San Joaquin Basin Action Plan lands and the East Gallo property) and the Grassland Resource Conservation District (GRCD)lands could include an estimated 2,000 acres of permanent ponds, 36,000 acres of seasonal marshes, and 2,000 acres dedicated to growing waterfowl food plants such as watergrass and smartweed. Water supplies available to state refuges, the East Gallo property, and the GRCD under the No-Action Alternative would limit the flexibility of refuge managers to use adaptive management techniques to adjust the timing and locations of wetland habitats to maximize their benefits to wildlife.

The relative numbers of waterfowl and other waterbirds that visit the refuges, expressed by use-day indices (one use-day equals one bird present at a refuge for one day), reflect the potential use of refuge wetlands under the No-Action Alternative. Use-day indices were extrapolated from Level 2 estimates provided in Reclamation in the 1992 Refuge Water Supply Study. These values are included to provide an approximate baseline for comparison with the other alternatives. Actual numbers of ducks and geese visiting the Central Valley each year would vary with population trends in the Pacific Flyway and with the regional availability of suitable wetland habitats.

In dry winters, private wetland and flooded rice field acreages are reduced compared to normal and wet years. Under these conditions, managed refuge wetland habitats are especially important to waterfowl. Limited wetland areas and inadequate food supplies could result in migratory waterfowl departing from the Sacramento Valley with inadequate energy reserves to fuel long-distance migrations and reproductive activities. For example, body weight losses and reduced fat reserves of northern pintails have been attributed to reduced availability of wetland habitats and rice field foraging areas in the Central Valley during a dry winter. Weight losses also could adversely affect or delay the reproduction of this species in the northern breeding grounds.

Water supplies under the No-Action Alternative could limit late-season wetland acreages and nesting opportunities for ducks, shorebirds, and wading birds that nest in the Central Valley. Lack of suitable late-season water supplies also could increase stagnation of waters in permanent ponds and seasonal marshes, and could increase the potential for outbreaks of waterfowl diseases such as botulism and avian cholera. Similarly, the limited summer and early fall water available to refuges under the No-Action Alternative would not permit refuge managers to adapt their water use to prevent or eliminate waterfowl disease outbreaks in wetland habitats.

Duck clubs and other private wetlands in the Sacramento Valley receive their water supplies from a variety of sources, including pumped groundwater and direct purchases of CVP and non-CVP sources from local water districts and agencies. Aside from duck clubs and other managed wetlands in the Grasslands area of the San Joaquin Valley, the PEIS alternatives do not consider water deliveries to privately managed wetlands in the Central Valley. Therefore, duck clubs and other private wetlands in the Sacramento Valley should continue to receive their historical water deliveries in dry, normal, and wet years under the No-Action Alternative.

Saline Habitat in Delta

Salinity values on the southwestern end of the Delta at Chipps Island would range from approximately 0.5 to 6 parts per thousand (ppt) annually, which is the range for freshwater marsh habitat. West of Chipps Island in the vicinity of Port Chicago, and further west at Benicia, the salinity ranges from 3 to 13 ppt and from 5 to 16 ppt, respectively. At those two locations, brackish and saltmarsh habitats become prevalent.

The distribution and abundance of common freshwater marsh plants in the Delta, including cattails and common tule, would not change. The abundance and distribution of common plants occurring in brackish marshes (e.g., Pacific alkali bulrush) or species occurring in salt marshes (e.g., saltgrass and pickleweed) also would not change. The abundance of wildlife species that use these wetland habitats would remain unchanged as well.

Special-Status Species

Under the No-Action Alternative, urban development in agricultural habitats and grassland (including vernal pools) and valley foothill hardwood habitats could affect populations of up to:

- 117 special-status plants in the Sacramento River region, including up to 23 species of plants that are federally-listed or proposed as threatened or endangered;

- 45 special-status plants in the Sacramento-San Joaquin Delta Region, including nine species of plants that are federally-listed or proposed as threatened or endangered; and

- 105 special-status plants in the San Joaquin River Region, including 23 species of plants, that are federally-listed or proposed as threatened or endangered.

Urban development in agricultural habitats and grassland and valley foothill hardwood habitats could adversely affect populations of up to 62 special-status plants in the Tulare Lake Region, including 17 species of plants that are federally-listed or proposed as threatened or endangered.

The conversion of rice or small grain crops to other crops could reduce habitat for the giant garter snake, Aleutian Canada goose, and Swainson's hawk. Waterfowl abundance could also be reduced, indirectly affecting potential prey for peregrine falcons. Urban development in the Sacramento Valley grasslands and valley foothill hardwood forests could adversely affect one federal candidate species and the following state-listed and federally-listed species: Swainson's hawk, valley elderberry longhorn beetle, and giant garter snake.

The conversion of small grain crops to other crops in the Delta under the No-Action Alternative could reduce habitat for the Aleutian Canada goose and also could reduce waterfowl abundance, indirectly affecting potential prey for peregrine falcons.

Urban development in the San Joaquin Valley grasslands, alkali desert scrub, and valley foothill hardwood forests could affect four federal candidates and the following state-listed and federally-listed species: valley elderberry longhorn beetle, giant garter snake, blunt-nosed leopard lizard, Aleutian Canada goose, giant kangaroo rat, Fresno kangaroo rat, San Joaquin antelope squirrel, and San Joaquin kit fox. Under the No-Action Alternative, subsidence would continue to occur along the west side of the San Joaquin Valley. Localized flooding associated with subsidence could adversely affect the giant kangaroo rat and Fresno kangaroo rat by flooding burrows.

Continued use of herbicides could adversely affect special-status plants. Pesticides could adversely affect the valley elderberry longhorn beetle. Rodenticides could adversely affect Swainson's hawks through secondary poisoning.

Areas with Drainage Problems

Approximately 45,000 acres of agricultural land would be retired by the state. These lands would be seeded with grasses to support grazing or occasional dryland farming. Where populations of special-status plants occur near retired lands, some of these species could colonize the grazed retired lands. Colonization of retired lands by special-status plants could be sporadic and occur over a long time. If these lands are used as rangeland, they could provide potential habitat for the blunt-nosed leopard lizard, giant kangaroo rat, San Joaquin antelope squirrel, and San Joaquin kit fox. If land previously used for cotton production is retired, it may require additional seedings because of residual amounts of herbicide that may remain in the soil. These reseeded lands could provide potential habitat for common wildlife, such as the savannah sparrow, red-tailed hawk, California vole, deer mouse, western fence lizard, and western toad.

The number of acres of evaporation ponds in the San Joaquin River and Tulare Lake regions is projected to increase by the year 2020 even with the retirement of farmland. Impacts on waterfowl and shorebirds could continue to occur. The magnitude of the impacts could depend, in part, on the design of individual evaporation ponds and on the availability of alternative wetlands that could provide suitable waterfowl and shorebird habitat.

ALTERNATIVE 1

Natural and Agricultural Communities

Cropping patterns in the Central Valley would change compared to the No-Action Alternative resulting in minor changes (less than 1 percent) in acres planted in pasture, grain, and rice. It is assumed that there would be no increase in the amount of cotton grown in the Sacramento Valley compared to the No-Action Alternative. Changes in agricultural habitats are small and would not affect the distribution or population levels of common wildlife species. It is assumed that urban development would not change compared to the No-Action Alternative.

Under Alternative 1, approximately 1,500 acres of agricultural land in the Sacramento Valley, 100 acres in the Delta, 22,400 acres in the San Joaquin River Region, and 21,900 acres in the Tulare Lake Region would be fallowed as compared to the No-Action Alternative. These lands to be fallowed are assumed to be scattered throughout the region. These parcels could be invaded by a wide variety of ruderal species, including bindweed, ripgut brome, Mediterranean barley, amaranth, yellow star-thistle, and Russian thistle. These scattered, small patches of ruderal vegetation could provide limited habitat for common plant or wildlife species. Areas previously planted with cotton could be revegetated more slowly than other former crop areas because of residual levels of herbicides. Fallowed parcels could provide short-term habitat for common wildlife species associated with ruderal habitat, such as the house mouse, deer mouse, savannah sparrow, and western fence lizard.

Annual pesticide use would be reduced for herbicides and insecticides compared to the No-Action Alternative. The small reduction in use of these pesticides could provide a minor benefit to common vegetation and wildlife species. It is assumed that the use of rodenticides would not change compared to the No-Action Alternative.

Rivers and Reservoirs

Under Alternative 1, the changes in river stages would be minor. Changes in the extent and condition of riparian communities would be minor as a result of these small hydrologic changes.

Under Alternative 1, restoration activities of riparian habitat could have a beneficial effect on the extent and condition of riparian habitat in this area. Common riparian plant species, including willows, Fremont cottonwood, and Oregon ash could benefit. Common wildlife species, including the California vole, gopher snake, black phoebe, and orange-crowned warblers could benefit. In the San Joaquin River Region, raccoon, American goldfinch, Nuttall's woodpecker, and green-backed heron also could benefit. The magnitude of the beneficial impact could depend upon which restoration actions are taken and on the availability of water. Restoration activities would occur on most Central Valley streams that flow to the Delta. However, under

Alternative 1 flow conditions only improve on the Sacramento, American, Stanislaus, and San Joaquin rivers, and on Clear, Battle, Mill, Deer, Cow, and Big Chico creeks. Therefore the benefits of the restoration activities would not be fully realized on the other streams in which flow requirements are not met under Alternative 1.

Hydrologic conditions in wetlands associated with riparian habitats would not differ from those described previously for riparian communities. Common wetland plant species, including tules, cattails, sedges, and rushes, would not be affected. Common wildlife species that use these wetland habitats, including bitterns, coots, rails, Pacific treefrogs, and bullfrogs, also could not be affected. Under Alternative 1, habitat restoration could increase the availability of fish that provide prey for wildlife, which could benefit wildlife that depend on fish for food.

Waterfowl and Shorebirds

Under Alternative 1, with the provision of a firm Level 2 water supply, additional lands would be put under management at wildlife refuges. Although this additional acreage would represent a substantial benefit to migratory waterfowl and other waterbirds compared to the No-Action Alternative, water supplies would still be inadequate for optimal wetlands management.

Relative indices, based upon total values for water supplies, indicate that the number of use-days for ducks, geese, and other waterbirds could be higher under Alternative 1 than under the No-Action Alternative. Under Alternative 1, higher levels of bird use and less than optimal wetlands availability could result in increased crowding of waterfowl and could promote outbreaks of botulism, avian cholera, and other diseases on these managed wetland areas. Problems associated with waterfowl crowding and disease outbreaks are expected to be less severe than under the No-Action Alternative, however, and the overall effects of Alternative 1 should be beneficial.

Alternative 1 would result in approximately 55,000 additional acres of flooded fields in the Sacramento Valley, approximately 13,000 additional acres in the Delta, and 13,000 additional acres in the San Joaquin River Region. These new seasonal wetlands could offer major benefits for migratory waterfowl, shorebirds, and wading birds because they could provide important alternative foraging and resting habitat to existing state and federal wildlife refuges, duck clubs, and other private wetlands in the Central Valley.

Saline Habitat in the Delta

Under Alternative 1, salinity changes at Chipps Island in the Delta, and Port Chicago and Benicia west of the Delta boundary, would be minor and have no impact on the wetland communities. Common wetland plant species and common wildlife species using wetland habitats would not be affected.

Special-Status Species

Impacts on special-status species due to urban development under Alternative 1 would be the same as under the No-Action Alternative. The conversion of rice or small grain crops in the

Sacramento Valley and the Delta, and the conversion of grassland and valley foothill hardwoods would have impacts similar to those described for the No-Action Alternative.

Under Alternative 1, a minimal amount of land would be fallowed in the Sacramento Valley and Delta Regions. Approximately 22,400 acres of agricultural land would be fallowed in the San Joaquin River Region. Fallowed lands would potentially be scattered throughout the region, and ruderal vegetation could invade the fallowed fields. The loss of less than 1 percent of potential agricultural habitat for the Aleutian Canada goose could have little effect on the population. Swainson's hawks could continue to use these areas. These scattered isolated patches of ruderal vegetation could not provide the opportunity for increases in special-status plant populations or habitat but could provide low-quality potential habitat for the Swainson's hawk, San Joaquin kit fox, San Joaquin antelope squirrel, and blunt-nosed leopard lizard.

Under Alternative 1, the restoration of riparian habitat on the Sacramento River and its tributaries as well as on the Yuba, American, and Cosumnes rivers could beneficially affect up to nine special-status plants. None of these species are federally-listed or proposed as threatened or endangered. Restoration of riparian habitat could benefit the valley elderberry longhorn beetle.

Additional water deliveries to federal and state refuges and the GRCD, and field flooding could provide additional potential habitat for the giant garter snake and Aleutian Canada goose.

Freshwater, brackish water, and salt marshes would not be affected; and no impacts on special-status species should be associated with these habitats.

Under Alternative 1, annual herbicide and insecticide use in the Central Valley would be reduced compared to the No-Action Alternative. This reduction could provide a small benefit to special-status plants and the valley elderberry longhorn beetle. The potential adverse secondary effects of rodenticides on Swainson's hawks and San Joaquin kit fox would be similar to those described for the No-Action Alternative. Similar reductions in pesticides would occur in the Delta, San Joaquin River Region, and Tulare Lake Region.

Areas with Drainage Problems

Under Alternative 1, Reclamation would acquire and retire 30,000 acres of agricultural land to improve water quality, acquire water, or restore or enhance wildlife habitat. Alternative 1 assumes that all retired land (75,000 acres) could be maintained in agricultural production or restored to natural habitats. Under Scenario 1, agricultural habitat would not benefit special-status plant populations, but could provide low quality habitat for special-status wildlife. Under Scenario 2, introduction of populations and enhancement of habitat for special-status plants dependent on grassland and alkali desert scrub habitats could be part of the restoration efforts. These areas may be used to implement conservation objectives for regional habitat conservation plans. Population introductions and habitat restoration could result in beneficial impacts on special-status plants in the San Joaquin River and Tulare Lake Regions.

Restoration efforts could provide high-quality habitat for one federal candidate species and for the following state-listed and federally-listed wildlife species: Swainson's hawk, Aleutian

Canada goose, blunt-nosed leopard lizard, Tipton kangaroo rat, giant kangaroo rat, San Joaquin antelope squirrel, and San Joaquin kit fox.

The number of acres of evaporation ponds in the San Joaquin River and Tulare Lake regions is projected to increase by 2020 even with the retirement of some farmlands. Impacts on waterfowl and shorebirds would be similar to the No Action Alternative. The magnitude of the impacts would depend on the design of individual evaporation ponds and on the availability of alternative wetlands that could provide suitable waterfowl and shorebird habitat.

ALTERNATIVE 2

Natural and Agricultural Communities

Changes in agricultural habitats would be minor and would not impact the distribution or number of common wildlife in the Sacramento River Region. The amount of cotton grown in the Sacramento Valley would not increase from the No-Action Alternative. It is assumed that urban development would not change compared to the No-Action Alternative.

Approximately 6,700 acres of farmland in the Sacramento Valley, 1,900 acres in the Delta, 66,000 acres in the San Joaquin River Region, and 20,000 acres in the Tulare Lake Region would be fallowed under Alternative 2 as compared to the No-Action Alternative. It is assumed that the fallowed land would be distributed in small, isolated parcels throughout each region and that impacts would be similar to Alternative 1.

Annual application of herbicides and insecticides would be reduced compared to the No-Action Alternative. The small reduction in use of these pesticides would provide a minor benefit to common vegetation and wildlife. It is assumed that the use of rodenticides would not change compared to the No-Action Alternative.

River and Reservoirs

Under Alternative 2, river stages in the Sacramento River would be similar to the stages under Alternative 1. Changes in the extent and condition of riparian communities, compared to those identified under the No-Action Alternative, would be minor as a result of these small hydrologic changes.

Higher spring flows in the Merced and Lower San Joaquin rivers, as compared to those under the No-Action Alternative, could provide an enhanced opportunity for riparian species to reproduce, especially during dry years. The magnitude of this effect cannot be determined with existing data. Common plants that could benefit include sandbar willow, Fremont cottonwood, and red willow. Common wildlife that could benefit include several small mammal species, song sparrows, and gopher snakes.

Under Alternative 2, there would be little change in the amount of shallow water, deep water, and open water habitats in the reservoirs compared to the No-Action Alternative. Additionally, the availability of fish used as prey by wildlife would not change. Therefore, fall and winter waterbird uses would not change as compared to the No-Action Alternative.

Waterfowl and Shorebirds

Increased water deliveries (Level 4) to Sacramento Valley refuges would permit optimal management of existing and new wetlands. This could benefit migratory and breeding waterfowl and other waterbirds and wildlife.

Reclamation and DFG have summarized the following benefits of optimal (Level 4) water deliveries to Sacramento Valley refuges:

- earlier fall flood-up schedule for seasonal marshes to allow increased wildlife use, while easing water conveyance capacity constraints due to timing;
- maintenance of additional acreage of both summer water and permanent pond habitat types for both wildlife use and vegetation improvement;
- increased acreage of watergrass habitat and increased frequency of irrigation, if necessary, to provide a high-quality carbohydrate food source for waterfowl and other waterbirds, while easing potential waterfowl crop depredation problems on nearby agricultural lands;
- increased "flow-through" of maintenance water levels in all wetland habitat units on the refuges to decrease the potential for disease outbreaks, especially botulism, in waterfowl and other waterbirds using these habitats;
- maintenance of water depths, using year-round water delivery, which provide optimum foraging conditions for the majority of avian species;
- control of undesirable vegetation species, such as cocklebur, using deep irrigation and maintenance for periods of two to four weeks during the summer; and
- development of an additional 400-500 wetland acres throughout the Sacramento NWR Complex during the next several years.

Each of these benefits will be described in more detail in the specific master plans for individual refuges. As part of ongoing analysis and adaptive management on Sacramento Valley refuges, managers are currently preparing water management strategies for the next 10 years. These plans will include detailed discussions of refuge-specific resource objectives, types of wetland habitats to be maintained or created, and water supplies and conveyance facilities that are needed.

The overall objectives of refuge water management strategies anticipated under Alternative 2 would enable refuge managers to implement their master plans to optimize the foraging, resting, and breeding habitats for wetland-dependent wildlife.

No impacts on duck clubs and other private lands in the Central Valley were identified because Alternative 2 would not affect water deliveries from other water sources for these private waterfowl habitat areas. Therefore, duck clubs and other private wetlands in the Central Valley should continue to receive their historical water deliveries in dry, normal, and wet years under this alternative.

Under Alternative 2, fall field flooding would result in approximately 55,000 additional acres of habitat in the Sacramento Valley, 13,000 additional acres in the Delta, and 13,000 additional acres in the San Joaquin River Region as compared to the No-Action Alternative. These new seasonal wetlands could provide important alternative foraging and resting habitat to migratory waterfowl, shorebirds, and wading birds in addition to habitat currently available at private duck clubs and other refuges. Additional flooded fields could minimize problems associated with crowding of birds, such as depletion of food supplies and outbreaks of waterfowl disease.

Saline Habitat in the Delta

Under Alternative 2, salinity changes at Chipps Island in the Delta, and Port Chicago and Benecia west of the Delta boundary, would be minor and are not expected to impact wetland communities. Common wetland plants and common wildlife using wetland habitats would not be affected.

Special-Status Species

Under Alternative 2, urban development would not change compared to the No-Action Alternative; therefore, no additional impacts on special-status plants would result from urban development. The conversion of rice or small grain crops to cotton and the conversion of grassland and valley foothill hardwoods to agricultural uses or urban development would have impacts similar to those described for the No-Action Alternative.

Under Alternative 2, approximately 8,400 acres of agricultural land would be fallowed in the Sacramento Valley and Delta Regions, 66,000 acres of agricultural land would be fallowed in the San Joaquin River Region and 20,000 acres in the Tulare Lake Region. The beneficial impacts of this fallowing would be minor and similar to those described for Alternative 1.

Under Alternative 2, subsidence would increase along the west side of the San Joaquin Valley as compared to the No-Action Alternative. Localized flooding associated with subsidence could adversely affect the giant kangaroo rat and Fresno kangaroo rat by flooding burrows.

Under Alternative 2, annual application of herbicides and insecticides would be reduced. This small reduction could provide a minor benefit to special-status plants and to the valley elderberry longhorn beetle.

Under Alternative 2, restoration of riparian habitat could benefit up to nine special-status plants. Restoration of riparian habitat could benefit the valley elderberry longhorn beetle and giant garter snake.

Changes in river flows would have little effect on riparian habitat and would not adversely affect habitat used by the bank swallow, valley elderberry longhorn beetle, giant garter snake, black rail, and California clapper rail.

Areas with Drainage Problems

The number of acres of evaporation ponds in the San Joaquin River and Tulare Lake regions is projected to increase by 2020 even with the retirement of some farmlands. Impacts on waterfowl and shorebirds would be similar to the No-Action alternative. Approximately 75,000 acres of retired lands would be maintained in agricultural production or restored to natural habitats as previously described under Alternative 1.

ALTERNATIVE 3

Natural and Agricultural Communities

Approximately 3,900 acres of agricultural land in the Sacramento River Region, 1,900 acres in the Delta, and 19,000 acres in the Tulare Lake Region would be fallowed under Alternative 3 as compared to the No-Action Alternative. It is assumed that fallowed land in the Sacramento River, the Delta, and Tulare Lake Regions would be distributed in small, isolated parcels throughout the region and that impacts would be similar to Alternative 1.

Because of the amount of land fallowed in the San Joaquin River Region, it is assumed that approximately 15 percent of the fallowed land (40,500 acres) would be adjacent to wildlife refuges, or that individual parcels would be large enough to provide potentially high-quality habitat. Conservation easements could be acquired, and management of these parcels should include vegetation and wildlife objectives. These changes could benefit common vegetation and wildlife.

Under Alternative 3, herbicide and insecticide use would be reduced compared to the No-Action Alternative. The reduction in use of these pesticides could provide a minor benefit to common vegetation and wildlife. It is assumed that the use of rodenticides would not change compared to the No-Action Alternative.

Rivers and Reservoirs

Under Alternative 3, river stages in the rivers in the Sacramento River Region would be similar to the stages under Alternative 1. Changes in the extent and condition of riparian communities compared to those identified under the No-Action Alternative would be minor as a result of these small hydrologic changes.

Spring flows in the Merced and Lower San Joaquin rivers are expected to be higher under Alternative 3 than under the No-Action Alternative, providing an enhanced opportunity for riparian species to reproduce, especially during dry years. Common plants that could benefit include sandbar willow, Fremont cottonwood, and red willow. Common wildlife that could benefit include several small mammal species, song sparrows, gopher snakes, western fence lizard, and California vole.

Mean monthly flows and river stages in the Sacramento-San Joaquin Delta Region under Alternative 3 would result in a somewhat higher level in spring as compared to the No-Action Alternative. Riparian reproduction could increase under this alternative, particularly in dry years.

Common riparian plants that could benefit include Fremont cottonwood and black willow. Common wildlife that could benefit include migratory birds, such as western tanager, yellow warbler, and black-headed grosbeak.

Under Alternative 3, there would be little change in the amount of shallow water, deep water, and open water habitats in the reservoirs compared to the No-Action Alternative. Additionally, the availability of fish used as prey by wildlife is not expected to change. Similarly, fall and winter waterbird uses are not expected to change as compared to the No-Action Alternative.

Waterfowl and Shorebirds

Changes in vegetation and wildlife at the refuges and field flooding under Alternative 3 would be similar to those changes discussed under Alternative 2.

Saline Habitat in the Delta

Under Alternative 3, salinity changes at Chipps Island in the Delta, and Port Chicago and Benicia west of the Delta boundary would be minor and are not expected to affect wetland communities.

Special-Status Species

The conversion of rice or small grain crops to cotton and the conversion of grassland and valley foothill hardwoods to agricultural uses or urban development would have impacts similar to those described for the No-Action Alternative. It is assumed that no natural habitat would be affected by new agricultural production.

Under Alternative 3, approximately 3,900 acres of agricultural land in the Sacramento Valley, 1,900 acres in the Delta, and 19,000 acres in the Tulare Lake Region would be fallowed. It is assumed that these fallowed lands would be isolated and scattered throughout each region and that the impacts of this fallowing would be similar to those presented under Alternative 1. Under Alternative 3, approximately 270,000 acres of agricultural land would be fallowed in the San Joaquin River Region. Most of this fallowed land would be distributed in small, isolated parcels throughout the region. These parcels could be invaded by a wide variety of ruderal species, and impacts are expected to be similar to those described for Alternative 1, providing low-quality potential habitat for the San Joaquin kit fox and blunt-nosed leopard lizard.

Conservation easements could be acquired, and management of these parcels should include vegetation and wildlife objectives. Where these lands are near existing wildlife refuges, the fallowed lands could be used for habitat enhancement. Up to 110 special-status species could benefit from habitat enhancement, including 23 federally-listed or proposed plants in grassland, alkali desert scrub, and valley foothill hardwood habitats. One federal candidate and the following state-listed and federally-listed wildlife species also could benefit: Swainson's hawk, blunt-nosed leopard lizard, Aleutian Canada goose, giant kangaroo rat, Fresno kangaroo rat, San Joaquin antelope squirrel, and San Joaquin kit fox.

Annual use of herbicides and insecticides in the Central Valley would be reduced compared to the No-Action Alternative. This small reduction could provide a minor benefit to special-status plants and valley elderberry longhorn beetle.

The potential adverse effects of rodenticides on Swainson's hawks and San Joaquin kit fox would be similar to those described for the No-Action Alternative.

Under Alternative 3, impacts of riparian habitat restoration on special-status plants would be the same as those described under Alternative 1. Restoration of riparian habitat could beneficially affect up to nine special-status plants. None of these species are federally-listed or proposed as threatened or endangered. Restoration of riparian habitat could benefit the valley elderberry longhorn beetle, giant garter snake, riparian brush rabbit, and Aleutian Canada goose.

Changes in river flows would have little effect on wetland and riparian habitat and are therefore not likely to affect habitat used by the bank swallow, valley elderberry longhorn beetle, and giant garter snake. Riverine habitat quality would not change; therefore, it should not affect any special-status species.

Areas with Drainage Problems

The area of evaporation ponds in the San Joaquin River and Tulare Lake regions is projected to increase by the year 2020 even with the retirement of some farmlands. Impacts on waterfowl and shorebirds would be similar to the No-Action Alternative. Approximately 75,000 acres of retired lands could be maintained in agricultural production or restored to natural habitats as described under Alternative 1.

ALTERNATIVE 4

Natural and Agricultural Communities

Under Alternative 4, approximately 35,000 acres of agricultural land in the Sacramento Valley, 3,000 acres in the Delta, 305,000 acres in the San Joaquin River Region, and 19,000 acres in the Tulare Lake Region would be fallowed as compared to the No-Action Alternative. It is assumed that land would be fallowed in isolated parcels distributed throughout each region.

Because of the increase in the amount of land fallowed in the San Joaquin River Region, it is assumed that approximately 15 percent of the land (45,750 acres) would either be adjacent to wildlife refuges, or would be large enough to provide potentially high-quality habitat. Conservation easements could be acquired, and management of these parcels should include vegetation and wildlife objectives. These changes could benefit common vegetation and wildlife.

Under Alternative 4, herbicide and insecticide use would be reduced compared to the No-Action Alternative and Alternatives 1, 2, and 3. The small reduction in use of these pesticides could provide a minor benefit to common vegetation and wildlife. It is assumed that the use of rodenticides would not change compared to the No-Action Alternative.

Rivers and Reservoirs

Under Alternative 4, river stages in the rivers in the Sacramento River Region would be similar to those presented under Alternative 1. Changes in the extent and condition of riparian communities compared to those identified under the No-Action Alternative would be minor as a result of these small hydrologic changes.

Higher spring and earlier summer flows in the Feather, Yuba, Merced and Lower San Joaquin rivers as compared to those identified under the No-Action Alternative could promote reproduction of riparian species, especially during dry years. Common plants that could benefit include sandbar willow, Fremont cottonwood, western sycamore, Oregon ash, and red willow. Common wildlife that could benefit include several small mammal species, song sparrows, northern flicker, gopher snakes, western fence lizard, and California vole.

The extent of riparian communities along the American River is expected to decrease during average years and especially during dry years because summer stages would be substantially lower than under the No-Action Alternative. Common wildlife would be affected, but these species are locally abundant and the decrease would not affect their overall numbers. To minimize impacts on riparian communities, riparian habitat along the lower American River could be restored to compensate for impacts on riparian communities anticipated from substantially lower summer flows.

Mean monthly flows and river stages in the Sacramento-San Joaquin Delta Region under Alternative 4 would show a somewhat higher level in spring as compared to the No-Action Alternative. Riparian reproduction could increase under this alternative, particularly in dry years. Common riparian plants that could benefit include Fremont cottonwood and black willow. Common wildlife that could benefit include migratory birds, such as western tanager, yellow warbler, and black-headed grosbeak.

Under Alternative 4, there would be little change in the amount of shallow water, deep water, and open water habitats in the reservoirs as compared to the No-Action Alternative. Additionally, the availability of fish used as prey by wildlife would not change. Therefore, fall and winter waterbird use would not change as compared to the No-Action Alternative.

Waterfowl and Shorebirds

Changes in vegetation and wildlife at the refuges and field flooding would be similar to those changes discussed under Alternative 2.

Saline Habitat in the Delta

Under Alternative 4, salinity changes at Chipps Island in the Delta, and Port Chicago and Benicia west of the Delta boundary, would be minor and would not affect wetland communities.

Special-Status Species

The conversion of rice or small grain crops to cotton and the conversion of grassland and valley foothill hardwoods to agricultural uses or urban development would have impacts similar to those described under the No-Action Alternative. It is assumed that no natural habitat would be affected by new agricultural production.

Under Alternative 4, approximately 35,000 acres of agricultural land in the Sacramento Valley, 3,000 acres in the Delta, and 19,000 acres in the Tulare Lake Region would be fallowed. It is assumed that these parcels would be isolated from one another and scattered throughout each region. Ruderal vegetation could invade these fallowed lands and could potentially compete with establishment of special-status plant populations or with habitat for special-status plants or wildlife. No change in special-status species would result as compared to the No-Action Alternative. Under Alternative 4, approximately 305,000 acres of agricultural land would be fallowed in the San Joaquin River Region. An estimated 15 percent of these fallowed lands (45,750 acres) could be used for habitat enhancement for special-status plants, and management of these parcels should include objectives for wildlife. These actions could benefit federal candidate and listed wildlife species, including the blunt-nosed leopard lizard, Aleutian Canada goose, giant kangaroo rat, Fresno kangaroo rat, and San Joaquin kit fox; and up to 110 special-status plants, including 23 federally-listed or proposed species in grassland, alkali desert scrub, and valley foothill hardwood habitats.

Annual use of herbicides and insecticides in the Sacramento Valley, Delta, and Tulare Lake regions would be reduced compared to the No-Action Alternative. In the San Joaquin River Region, use of herbicides and insecticides would be reduced compared to Alternatives 1, 2, and 3. The reductions could provide a minor benefit to special-status plants and to valley elderberry longhorn beetle.

The potential adverse effects of rodenticides on Swainson's hawks and San Joaquin kit fox would be similar to those described for the No-Action Alternative.

Under Alternative 4, impacts of riparian habitat restoration on special-status plants would be similar to those described under Alternative 1. Restoration of riparian habitat could beneficially affect up to nine special-status plants. None of these species are federally-listed or proposed as threatened or endangered. Restoration of riparian habitat could benefit the valley elderberry longhorn beetle, giant garter snake, riparian brush rabbit, and Aleutian Canada goose.

Restoration of riparian habitat on the Mokelumne, Merced, Tuolumne, and Stanislaus rivers could beneficially impact up to five special-status plants. None of these species are federally-listed or proposed as threatened or endangered.

Areas with Drainage Problems

The number of acres of evaporation ponds in the San Joaquin River and Tulare Lake regions is projected to increase by the year 2020 even with the retirement of some farmlands. Impacts on waterfowl and shorebirds would be similar to the No-Action Alternative. Approximately 75,000

acres of retired lands would be maintained in agricultural production or restored to natural habitats as described in Alternative 1.

ALTERNATIVE 5

Natural and Agricultural Communities

Under Alternative 5, approximately 728,000 acres of agricultural land would be fallowed in the Sacramento Valley, 365,000 acres in the Delta, 995,000 acres in the San Joaquin River Region, and 417,700 acres in the Tulare Lake Region as compared to the No-Action Alternative.

Because of the amount of land fallowed in the Central Valley under Alternative 5, it is assumed that approximately 45 percent of the land (1.12 million acres) would be adjacent to wildlife refuges, or that individual parcels could be large enough to provide potentially high-quality habitat. Conservation easements could be acquired, and management of these parcels should include vegetation and wildlife objectives. These changes could benefit common vegetation and wildlife.

This could result in fewer impacts on common vegetation and wildlife compared to the No-Action Alternative.

Under Alternative 5, pesticide use would be reduced as compared to Alternatives 1, 2, 3, and 4. The reduction in use of these pesticides should provide a benefit to common vegetation and wildlife.

Rivers and Reservoirs

Under Alternative 5, river stages in the rivers in the Sacramento River Region would increase as compared to the No-Action Alternative. Higher spring and summer flows on the Upper Sacramento River could result in an increase in the reproduction of riparian species as well as in the extent of riparian communities. During the first few years, the higher stages during summer could cause mortality of flood-intolerant species, such as bigleaf maple and white alder, on streambanks and low terraces. After several years of implementation of Alternative 5, however, a new dynamic equilibrium of vegetation and river flows should establish, with a somewhat different elevational distribution of riparian species and a greater area occupied by riparian scrub and forest. Common riparian plants that could benefit include the black willow, narrow-leaf willow, Fremont cottonwood, mulefat, California grape, blue elderberry, box elder, and western sycamore. Common wildlife that could benefit include the red-tailed hawk, mourning dove, Wilson's and yellow warblers, great egret, beaver, California quail, and California ground squirrel.

Where the Lower Sacramento River is narrowly confined between levees, relatively little opportunity exists for expansion of riparian plants. As along the upper reach, some initial mortality of riparian plants could occur as a result of increased flows in summer; however, some riparian plants should be able to establish at higher elevations despite the presence of levees limiting available high-elevation habitats.

Higher stages in spring along the Feather River could increase reproduction of riparian plants; however, the steep decline of river stage between May and June may cause some mortality among juvenile riparian species due to drought stress. The net result of the change of the hydrologic regime could be an increase in the extent and density of riparian communities. Common riparian plants, including Fremont cottonwood, black willow, Oregon ash, and California grape, could benefit from higher river stages. Common wildlife that could benefit include the killdeer and spotted sandpiper.

Under Alternative 5, substantially higher flows from February to August in the lower Sacramento River, and from April to June in the lower San Joaquin River, could cause extended periods of inundation in the Delta in spring and summer. A large portion of the riparian vegetation in the Delta occurs along narrowly leveed waterways. Riparian plants in these areas could suffer increased mortality due to inundation during the growing season. Riparian vegetation on unleveed islands also could suffer mortality due to inundation. The extent of riparian communities could decrease in the Delta. Riparian communities in the Delta could be restored prior to water acquisition to mitigate the loss of riparian communities due to flooding. Large areas of historical wetlands and riparian communities in the Delta have been diked. Riparian vegetation could be restored in appropriate areas by restoring hydrology beneficial to riparian vegetation in diked areas and by planting riparian shrub and tree species in areas of appropriate elevation. Common riparian species such as black willow and Fremont cottonwood could be adversely affected. Common wildlife dependent on riparian habitats such as song sparrows could be adversely affected, but other wildlife that use open water could benefit. Changes in overall common wildlife abundance should be minor because the affected species are regionally and locally abundant.

Under Alternative 5, higher flows through the Delta would result in increased elevations of tidal water throughout the year. Wetland communities in the Delta are sensitive to changes in tidal elevation because inundation during high tides reduces the amount of light available to plants. Wetland communities depend on specific ranges of tidal elevation, and wetland plants that grow at lower elevations could be adversely affected due to decreased light levels during the growing season. Common wetland plants, including tules, cattails, and swamp smartweed, could be adversely affected. Common wildlife, including rails and herons that use wetlands, could be affected. Other common wildlife that use deep open water would benefit. The extent of wetland communities would likely decrease under Alternative 5. To reduce this impact, conditions favorable for wetlands could be created, to offset wetland community losses prior to water acquisition, or historical wetlands could be restored. Areas such as diked, formerly tidal areas that have not subsided to any great extent could be restored to tidal wetlands.

Under Alternative 5, high spring flows on the Merced River and Lower San Joaquin River could cause a substantially higher reproduction of riparian plants compared to the No-Action Alternative. Some of this increase may be lost because of summer mortality, especially during dry years, because of the steep decline in river stage during summer. The net result of the change in hydrology would be an increase in the extent of riparian communities. Common riparian plants, including sandbar willow, Fremont cottonwood, western sycamore and mulefat, would benefit. Common wildlife that could benefit include raccoons, western flycatchers, and northern rough-winged swallows.

Under Alternative 5, several riparian restoration actions would be taken in addition to the restoration actions included in Alternatives 1 through 4. The additional restoration actions would include restoration of a 50,000-acre meander belt in the upper Sacramento River, which would be of regional importance, and riparian restoration along Stony Creek and various Sacramento River tributaries, which would be of local importance. Restoration of riparian habitat along the Mokelumne, Merced, Tuolumne, and Stanislaus rivers could locally improve the extent and condition of riparian habitats. The magnitude of the beneficial effect would depend on which restoration actions are taken. Restoration of riparian habitat and spawning gravel in rivers on the east side of the San Joaquin River could increase salmonid fish in the San Joaquin River and its tributaries. The availability of additional fish could benefit wildlife that feed on fish. The common riparian plants that could benefit also depend on what restoration actions are taken. Common wildlife that could benefit include the raccoon, American goldfinch, Nuttall's woodpecker, and green-backed heron.

Under Alternative 5, there would be little change in the amount of shallow water, deep water, and open water habitats in the reservoirs compared to the No-Action Alternative. Additional shallow water habitat and fish would be available in San Luis Reservoir. This may benefit common species; however, most use by these species would probably continue to occur in O'Neill Forebay because it provides better quality habitat. Reservoir fish populations may decline in New Melones and New Don Pedro reservoirs and Lake McClure and adversely affect common species, such as grebes. This may reduce use of the reservoirs; however, fall and winter waterbird use could not change substantially in all reservoirs compared to the No-Action Alternative.

Waterfowl and Shorebirds

Changes in vegetation and wildlife at the refuges and private wetlands would be similar to those changes discussed under Alternative 2.

Field flooding under Alternative 5 would not occur because such a large proportion of the total yield of the CVP project would be dedicated to maintaining fisheries flows. Thus, field flooding under Alternative 5 would be the same as that described for the No-Action Alternative. Some additional flooding of the Sutter and Yolo bypasses would occur under Alternative 5 compared to the No-Action Alternative, which would offer seasonal benefits to migratory waterfowl and other water birds.

Saline Habitat in the Delta

Under Alternative 5, salinity levels would decrease due to increased freshwater flows throughout the year. The salinity range would decrease at Chipps Island to approximately 0-1 parts per thousand (ppt). At Port Chicago and Benicia, the salinity ranges would decrease to 0-5 ppt and 3-8 ppt, respectively. The decrease in salinity ranges throughout the year potentially should allow the establishment of freshwater plants such as cattail and other species that are less tolerant of higher salinities. The tidally influenced brackish and salt marsh areas that currently exist west of the legal Delta, such as near Port Chicago and Benicia, could become freshwater marsh areas. The vegetation changes could include a change in species composition and plant community structure from a low-growing salt marsh to a taller, more robust community type. These changes

could affect the overall habitat and result in changes in wildlife use. Common salt marsh plants (e.g., pickleweed, saltwort, and fleshy jaumea) and brackish marsh plants (e.g., African brass-buttons and slough sedge) could decrease in abundance. Freshwater marsh plants (e.g., broadleaf cattail and rushes) could increase. Common wildlife that use salt marshes (e.g., the salt marsh yellowthroat and song sparrow) could decrease in abundance, and species that use freshwater marsh (e.g., marsh wrens, herons, and bitterns) could increase in abundance.

Special-Status Species

Under Alternative 5, urban expansion would be approximately 169,500 acres less than under the No-Action Alternative. Fewer populations of special-status plants should be adversely affected, including federally-listed threatened and endangered plants. Reduction in urban development also could reduce impacts on special-status wildlife that use grassland and valley foothill hardwood habitats.

Approximately 697,000 acres of pasture, rice, and grain in the Sacramento Valley would be fallowed. As much as 85 percent of this agricultural habitat potentially used by the giant garter snake and 63 percent of similar habitat used by the Aleutian Canada goose could be affected. Swainson's hawk would continue to use these areas.

An estimated 45 percent of the fallowed land (327,600 acres) in the Sacramento River Region could be used to acquire conservation easements and enhance habitat for special-status species. These actions could benefit the Swainson's hawk, giant garter snake, and Aleutian Canada goose and up to 126 special-status plants, including 23 federally-listed or proposed as threatened and endangered plants that occur in grassland, valley foothill hardwood, and valley foothill riparian habitats.

Increased flows in the Sacramento and Feather rivers, and extensive riparian restoration along rivers in the Sacramento River Region could benefit giant garter snake and valley elderberry longhorn beetle populations. Under Alternative 5, approximately 365,000 acres of agricultural land would be fallowed in the Sacramento-San Joaquin Delta Region. Where these lands are near existing wildlife refuges, federal conservation easements could be used to benefit plants and wildlife. An estimated 45 percent of the fallowed lands could be used for habitat enhancement, resulting in beneficial impacts on the giant garter snake and Aleutian Canada goose.

Under Alternative 5, riparian habitat in the Sacramento-San Joaquin Delta Region would decrease, resulting in a potential loss of populations and habitat of riparian-dependent special-status plants. Four special-status plants could potentially be impacted. This impact could be reduced through restoration of potentially affected habitat in riparian communities and in communities with riparian special-status plants. Habitat management and population establishment actions could be taken to increase the numbers of individuals and populations of riparian-dependent special-status plants occurring in the Sacramento-San Joaquin Delta. The loss of riparian communities could affect habitat occupied by the valley elderberry longhorn beetle.

Increased flows out of the Delta under Alternative 5 would result in reduced salinity in the marshes between Benicia and Antioch, including Suisun Marsh. Reduced salinity could result in

decreased habitat for special-status plants of saline emergent marsh and in increased habitat for special-status plants of freshwater emergent marsh. Habitat of special-status plants that occur in both freshwater and saline emergent marsh should be unchanged. Decreased salinity could result in the loss of habitat, and possibly populations, of Suisun thistle and soft bird's-beak: both species are proposed for federal listing as endangered. Decreased salinity could result in increased habitat for six special-status plants, none of which are federally-listed or proposed as threatened or endangered. The extent of habitat for three special-status plants that are tolerant of both freshwater and saline emergent marsh should remain unchanged. Habitat could be protected for Suisun thistle and soft bird's-beak through control of freshwater flows into selected marsh areas between Benecia and Antioch. Where control structures such as levees and tide gates exist, changes in salinity resulting from increased freshwater flows could be controlled to maintain existing saltwater and brackish water conditions in areas of saline emergent marsh that support populations or provide habitat for these two species. No field flooding would occur under Alternative 5. The amount of wetlands in the Delta should decline and freshwater marsh should replace brackish water and salt marsh. The loss of salt marsh habitat could adversely affect habitat required by the California clapper rail and salt marsh harvest mouse.

Under Alternative 5, approximately 397,000 acres of pasture and grain in the San Joaquin River Region would be fallowed, which could affect potential habitat for the giant garter snake and Aleutian Canada goose. A total of approximately 1 million acres of agricultural land would be fallowed in the San Joaquin River Region. An estimated 45 percent of the fallowed land could be used for habitat enhancement for special-status plants. These actions could benefit four federal candidate wildlife species and move toward recovery of federally-listed species, including the California red-legged frog, blunt-nosed leopard lizard, Aleutian Canada goose, giant kangaroo rat, Fresno kangaroo rat, and San Joaquin kit fox. Vegetation management could benefit up to 110 special-status plants, including 23 federally-listed or proposed as threatened or endangered plant species in grassland, valley foothill hardwood, and valley foothill riparian habitats.

Increased flows on the Merced and San Joaquin rivers could result in an increase in riparian habitats that support special-status plants. Habitat for up to five special-status plants occurring in riparian habitats could increase. None of these species are federally-listed or proposed as threatened or endangered. Additional wetlands along the Merced and lower San Joaquin rivers also could benefit the giant garter snake and California red-legged frog.

Under Alternative 5, approximately 417,000 acres of agricultural land would be fallowed in the Tulare Lake Region. An estimated 45 percent of the fallowed land (187,000 acres) could be used for habitat enhancement for special-status species. Management of these parcels should include objectives for wildlife, which could benefit three federal candidate wildlife species and move toward recovery of federally-listed wildlife species, including the blunt-nosed leopard lizard, giant kangaroo rat, Tipton kangaroo rat, and San Joaquin kit fox. Vegetation objectives could benefit up to 80 special-status plants, including 21 that are federally-listed or proposed as threatened and endangered and occur in grassland, valley foothill hardwood, valley foothill riparian, and alkali desert scrub.

Under Alternative 5, subsidence would increase in the San Joaquin River Region and Tulare Lake Region compared to the No-Action Alternative. Localized flooding associated with

subsidence could adversely affect the giant kangaroo rat and Fresno kangaroo rat by flooding burrows. Under Alternative 5, impacts for subsidence are greater than those described for the No-Action Alternative because groundwater recharge would be reduced due to the elimination of surface water application.

Under Alternative 5, herbicide and insecticide use in the Central Valley would be reduced compared to Alternatives 1, 2, 3, and 4. This reduction could benefit special-status plants. The potential adverse effects of rodenticides on Swainson's hawk could be reduced compared to the No-Action Alternative.

Under Alternative 5, riparian habitat restoration activities would be more extensive than under the other alternatives. Restoration of riparian habitat could increase habitat for riparian-dependent special-status plants. Alternative 5 should promote expansion of populations of these species. Riparian restoration activities could increase riparian habitat along the Sacramento and Feather rivers, providing benefits to some habitat occupied by valley elderberry longhorn beetle and giant garter snake. Increased flows on the Sacramento and Feather rivers could result in an increase in riparian habitats that support special-status plants. Habitat for riparian-dependent special-status plants could increase. Higher river flows could benefit some habitat occupied by the valley elderberry longhorn beetle and giant garter snake. Wetlands associated with these rivers also could be improved by higher flows. Lower flows in the American River should have little effect on these species.

Under Alternative 5, increased fish productivity in the Sacramento River and many of its tributaries could provide additional prey for nesting and wintering bald eagles. Reservoir habitat quality would not change; therefore, nesting or wintering bald eagles should not be affected.

Impacts on special-status plants resulting from riparian habitat restoration would be similar to those described for Alternative 1, except that restoration of the meander belt along the Sacramento River could create additional habitat for up to nine special-status plants. Restoration of riparian habitat on the Mokelumne, Merced, Tuolumne, and Stanislaus rivers could benefit up to five special-status plants. None of these species are federally-listed or proposed as threatened or endangered. Additional riparian habitat along these rivers should have little impact on valley elderberry longhorn beetle.

Under Alternative 5, Level 4 water deliveries to federal and state refuges could improve potential habitat for giant garter snake and Aleutian Canada goose. No field flooding would be available to enhance habitat for these species outside the refuges.

Areas with Drainage Problems

Under Alternative 5, the area of evaporation ponds in the San Joaquin River Region would decline compared to the No-Action Alternative because of the increase in fallowed lands in the San Joaquin River Region and the Tulare Lake Region. Fewer acres of evaporation ponds could reduce impacts on waterfowl and shorebirds. Approximately 75,000 acres of retired lands would be maintained in agricultural production or restored to natural habitats, as described in Alternative 1.

AIR QUALITY

Impacts to air quality from agricultural land use changes are dependent upon changes in cropping patterns which may result in (1) increased fallowed lands with increased wind erosion potential, and (2) decreases in field burning (particularly rice) and pesticide/fertilizer application. Because the alternatives do not result in major changes in irrigated acreage in other portions of the Study Area, the impact assessment associated with air quality is focused on the Central Valley portion of the Study Area.

NO-ACTION ALTERNATIVE

In the No-Action Alternative, agricultural land uses in the Central Valley would include similar crops and cropping patterns as those described in the Affected Environment. It is assumed that retired or fallowed lands would be reseeded with grasses and grazed by livestock or occasionally dryland farmed. These cultivation measures are similar to methods used on lands which have been historically fallowed due to crop rotation or periodic cropping pattern changes.

It is assumed that current policies and practices of regulatory agencies would continue at the present level of intensity. This would include the continuation of air quality monitoring and air quality compliance programs. These programs have targeted specific emissions categories in past years, and are associated with reductions of specific pollutants in the Central Valley. It is not known, however, the extent to which air quality conditions would be further affected by the continuation of these programs through the year 2022. Therefore, because the cultivated and fallowed acreage patterns are similar to historical patterns, it is anticipated that air quality under the No-Action Alternative would be similar to recent conditions described in the Affected Environment.

ALTERNATIVE 1

The overall reduction in irrigated acreage under Alternative 1 is compared to the No-Action Alternative would be less than 1 percent of the irrigated acreage in the Central Valley. It is assumed that the lands to be retired or fallowed would be reseeded with grasses and grazed by livestock or occasionally dryland farmed. These cultivation measures are similar to methods used on lands which have been historically fallowed due to crop rotation or periodic cropping pattern changes. Therefore, due to limited changes in land use and continuation of dryland farmed cultivation practices, it is anticipated that the level of wind erosion potential would not increase under Alternative 1 as compared to the No-Action Alternative.

The retirement and fallowing of land would also be associated with reductions in the use of farm equipment and application of pesticides and fertilizers. However, because the percentage of land that would be affected by these changes is small, it is anticipated that air quality conditions resulting from vehicle emissions and pesticide and fertilizer use would not change under Alternative 1 as compared to the No-Action Alternative.

ALTERNATIVE 2

The overall reduction in irrigated acreage under Alternative 2 as compared to the No-Action Alternative would be about 1.3 percent of the irrigated acreage in the Central Valley.

It is assumed that the lands to be retired or fallowed would be reseeded with grasses and grazed by livestock or occasionally dryland farmed. These cultivation measures are similar to methods used on lands which have been historically fallowed due to crop rotation or periodic cropping pattern changes. Therefore, due to relatively minor changes in land use and continuation of dryland farmed cultivation practices, it is anticipated that the level of wind erosion potential would increase under Alternative 2 as compared to the No-Action Alternative.

The retirement and fallowing of land would also be associated with reductions in the use of farm equipment and application of pesticides and fertilizers. However, because the percentage of land that would be affected by these changes is small, it is anticipated that air quality conditions resulting from vehicle emissions and pesticide and fertilizer use would not change under Alternative 2 as compared to the No-Action Alternative.

ALTERNATIVE 3

The overall reduction in irrigated acreage under Alternative 3 as compared to the No-Action Alternative would be about 4 percent of the irrigated acreage in the Central Valley.

It is assumed that 85 percent of the lands to be retired or fallowed would be reseed with grasses and grazed by livestock or occasionally dryland farmed. These cultivation measures are similar to methods used on lands which have been historically fallowed due to crop rotation or periodic cropping pattern changes The remaining 15 percent of the lands to be retired are assumed to be included in a conservation easement and managed to improve wildlife habitat, especially near refuges.

Due to relatively minor changes in land use with respect to the Central Valley, the inclusion of conservation easements for 15 percent of the land to be fallowed, and continuation of dryland farmed cultivation practices, it is anticipated that the level of wind erosion potential would not increase under Alternative 3 as compared to the No-Action Alternative.

The retirement and fallowing of land would also be associated with reductions in the use of farm equipment and application of pesticides and fertilizers. However, because the percentage of land that would be affected by these changes is small, it is anticipated that air quality conditions resulting from vehicle emissions and pesticide and fertilizer use would not change under Alternative 3 as compared to the No-Action Alternative.

ALTERNATIVE 4

The overall reduction in irrigated acreage under Alternative 4 as compared to the No-Action Alternative would be about 5 percent of the irrigated acreage in the Central Valley.

It is assumed that 85 percent of the lands to be retired or fallowed would be reseed with grasses and grazed by livestock or occasionally dryland farmed. These cultivation measures are similar to methods used on lands which have been historically fallowed due to crop rotation or periodic cropping pattern changes The remaining 15 percent of the lands to be retired are assumed to be included in a conservation easement and managed to improve wildlife habitat, especially near refuges.

Due to relatively minor changes in land use with respect to the Central Valley, the inclusion of conservation easements for 15 percent of the land to be fallowed, and continuation of dryland farmed cultivation practices, it is anticipated that the level of wind erosion potential would not increase under Alternative 4 as compared to the No-Action Alternative.

The retirement and fallowing of land would also be associated with reductions in the use of farm equipment and application of pesticides and fertilizers. However, because the percentage of land that would be affected by these changes is small, it is anticipated that air quality conditions resulting from vehicle emissions and pesticide and fertilizer use would not change under Alternative 4 as compared to the No-Action Alternative.

ALTERNATIVE 5

The overall reduction in irrigated acreage under Alternative 5 as compared to the No-Action Alternative would be about 36 percent of the irrigated acreage in the Central Valley.

It is assumed that 55 percent of the lands to be retired or fallowed would be reseeded with grasses and grazed by livestock or occasionally dryland farmed. These cultivation measures are similar to methods used on lands which have been historically fallowed due to crop rotation or periodic cropping pattern changes. The remaining 45 percent of the lands to be retired are assumed to be included in a conservation easement and managed to improve wildlife habitat, especially near refuges.

Due to the inclusion of conservation easements for 45 percent of the land to be fallowed, and continuation of dryland farmed cultivation practices, it is anticipated that the level of wind erosion potential will not increase under Alternative 5 as compared to the No-Action Alternative.

The retirement and fallowing of land would also be associated with reductions in the use of farm equipment and application of pesticides and fertilizers. The extensive land use changes that would occur in Alternative 5 would result in reduced application of pesticides and fertilizers. Therefore, air quality conditions associated with the use of pesticides and fertilizers would potentially under Alternative 5 as compared to the No-Action Alternative.

SOIL EROSION POTENTIAL

Impacts on soils and geology are dependent upon two major impact methodologies: (1) changes in cropping patterns which may result in increased fallowed lands with increased erosion potential, and (2) increased river flows which may result in increased bank erosion and associated siltation problems. The impact assessment associated with soils and geology is

focused on the Central Valley portion of the Study Area because the alternatives do not result in changes in streamflows or major changes in irrigated acreage in other portions of the Study Area.

NO-ACTION ALTERNATIVE

The No-Action Alternative does include the retirement of 45,000 acres of land identified in the San Joaquin Basin Drainage Program. This land was irrigated with SWP water and is projected to be retired and fallowed by the Year 2020 under a DWR program.

It is assumed that the lands to be retired or fallowed would be reseeded with grasses and grazed by livestock or occasionally dryland farmed. These cultivation measures are similar to methods used on lands which have been historically fallowed due to crop rotation or periodic cropping pattern changes.

Because the cultivated and fallowed acreage patterns are similar to historical patterns, it is anticipated that erosion potential under the No-Action Alternative would be similar to historical conditions.

ALTERNATIVE 1

The water management actions under Alternative 1 would primarily affect CVP water supplies. It is anticipated that reductions in CVP water supplies would be replaced by increases in groundwater pumping. Reduction in surface water supply availability under Alternative 1 would result in a reduction of less than 0.2 percent of irrigated lands in the Central Valley. Alternative 1 also includes retirement of about 30,000 acres identified to be retired in the SJVDP. This land has been irrigated with CVP water and would be purchased under Alternative 1 with Restoration Funds, in accordance with the provisions of CVPIA. The overall reduction in irrigated acreage under Alternative 1 as compared to the No-Action Alternative would be less than 1 percent of the irrigated acreage in the Central Valley.

It is assumed that the lands to be retired or fallowed would be reseeded with grasses and grazed by livestock or occasionally dryland farmed. These cultivation measures are similar to methods used on lands which have been historically fallowed due to crop rotation or periodic cropping pattern changes. Therefore, due to relatively minor changes in land use and continuation of dryland farming cultivation practices, it is anticipated that the level of erosion potential will not increase under Alternative 1 as compared to the No-Action Alternative.

The CVP is operated under Alternative 1 in an attempt to increase fall river releases into the Sacramento and American rivers as compared to the No-Action Alternative, per the Draft AFRP Plan. Increased reservoir releases are also made from Whiskeytown Lake to increase Clear Creek minimum flow year round, and from New Melones Reservoir to provide higher flows on the Stanislaus River to meet Draft AFRP Plan target flows in April through June. None of the increased flows exceed recent historic flows, except on Clear Creek. The increased flows would be released in accordance with Draft AFRP Plan target flows which include flow ramping limitations to protect aquatic species and prevent siltation due to bank erosion.

On Clear Creek, the flows would increase 25 to 300 percent above existing flows, depending upon the water year type and month. This increase in flow under Alternative 1 could increase erosion potential if the habitat restoration activities identified in Alternative 1 were not implemented. However, with full implementation of Alternative 1, including the habitat restoration activities and increased flows, erosion potential would not increase as compared to the No-Action Alternative. Therefore, the increased flows probably would not increase erosion potential under Alternative 1 as compared to the No-Action Alternative.

ALTERNATIVE 2

The water management actions under Alternative 2 would primarily affect CVP water supplies and water rights holders in the Stanislaus, Tuolumne, and Merced rivers watersheds. It is anticipated that reductions in CVP water supplies would be replaced by increases in groundwater pumping. However, the reduction in water rights holders water diversions would not be replaced by increased groundwater pumping. Alternative 2 also includes retirement of about 30,000 acres identified to be retired in the SJVDP. This land has been irrigated with CVP water and would be purchased under Alternative 2 with Restoration Funds, in accordance with the provisions of CVPIA. The overall reduction in irrigated acreage under Alternative 2 as compared to the No-Action Alternative would be about 1.3 percent of the irrigated acreage in the Central Valley.

It is assumed that the lands to be retired or fallowed would be reseeded with grasses and grazed by livestock or occasionally dryland farmed. These cultivation measures are similar to methods used on lands which have been historically fallowed due to crop rotation or periodic cropping pattern changes. Therefore, due to relatively minor changes in land use and to continuation of dryland farming cultivation practices, it is anticipated that the level of erosion potential will not increase under Alternative 2 as compared to the No-Action Alternative.

As discussed under Alternative 1, the increased flows probably would not increase erosion potential on the streams under Alternative 2 as compared to the No-Action Alternative.

ALTERNATIVE 3

The water management actions under Alternative 3 would primarily affect CVP water supplies and water rights holders in the Stanislaus, Tuolumne, and Merced rivers watersheds. It is anticipated that reductions in CVP water supplies would be replaced by increases in groundwater pumping. However, the reduction in water rights holders water diversions would not be replaced by increased groundwater pumping.

Alternative 3 also includes retirement of about 30,000 acres identified to be retired in the SJVDP. This land has been irrigated with CVP water and would be purchased under Alternative 3 with Restoration Funds, in accordance with the provisions of CVPIA. The overall reduction in irrigated acreage under Alternative 3 as compared to the No-Action Alternative would be about 4 percent of the irrigated acreage in the Central Valley.

It is assumed that 85 percent of the lands to be retired or fallowed would be reseeded with grasses and grazed by livestock or occasionally dryland farmed. These cultivation measures are

similar to methods used on lands which have been historically fallowed due to crop rotation or periodic cropping pattern changes. The remaining 15 percent of the lands to be retired are assumed to be included in a conservation easement and managed to improve wildlife habitat, especially near refuges.

Due to relatively minor changes in land use, the inclusion of conservation easements for 15 percent of the land to be fallowed and the continuation of dryland farming cultivation practices for the remaining portion of the land to be fallowed, it is anticipated that the level of erosion potential will not increase under Alternative 3 as compared to the No-Action Alternative.

As discussed under Alternative 1, the increased flows probably would not increase erosion potential on the streams under Alternative 3 as compared to the No-Action Alternative.

ALTERNATIVE 4

The water management actions under Alternative 4 would primarily affect CVP water supplies and water rights holders in the Stanislaus, Tuolumne, Merced, Yuba, Feather, Calaveras, and Mokelumne river watersheds. It is anticipated that reductions in CVP water supplies would be replaced by increases in groundwater pumping. However, the reduction in water rights holders water diversions would not be replaced by increased groundwater pumping. Alternative 4 also includes retirement of about 30,000 acres identified to be retired in the SJVDP. This land has been irrigated with CVP water and would be purchased under Alternative 4 with Restoration Funds, in accordance with the provisions of CVPIA. The overall reduction in irrigated acreage under Alternative 4 as compared to the No-Action Alternative would be about 5 percent of the irrigated acreage in the Central Valley.

It is assumed that 85 percent of the lands to be retired or fallowed would be reseeded with grasses and grazed by livestock or occasionally dryland farmed. These cultivation measures are similar to methods used on lands which have been historically fallowed due to crop rotation or periodic cropping pattern changes. The remaining 15 percent of the lands to be retired are assumed to be included in a conservation easement and managed to improve wildlife habitat, especially near refuges.

Due to relatively minor changes in land use, the inclusion of conservation easements for 15 percent of the land to be fallowed, and continuation of dryland farming cultivation practices for the remaining portion of the land to be fallowed, it is anticipated that the level of erosion potential will not increase under Alternative 4 as compared to the No-Action Alternative.

As discussed under Alternative 1, the increased flows probably would not increase erosion potential on the streams under Alternative 4 as compared to the No-Action Alternative.

ALTERNATIVE 5

The water management actions under Alternative 5 would primarily affect CVP water supplies and water rights holders in the Stanislaus, Tuolumne, Merced, Yuba, Bear, Feather, Calaveras, and Mokelumne river watersheds and in the Delta. It is anticipated that reductions in CVP water supplies and water rights holders water diversions would be due to sale by willing sellers, and

would not be replaced by increased groundwater pumping. Alternative 5 also includes retirement of about 30,000 acres identified to be retired in the SJVDP. This land has been irrigated with CVP water and would be purchased under Alternative 5 with Restoration Funds, in accordance with the provisions of CVPIA. The overall reduction in irrigated acreage under Alternative 5 as compared to the No-Action Alternative would be about 36 percent of the irrigated acreage in the Central Valley.

It is assumed that 55 percent of the lands to be retired or fallowed would be reseeded with grasses and grazed by livestock or occasionally dryland farmed. These cultivation measures are similar to methods used on lands which have been historically fallowed due to crop rotation or periodic cropping pattern changes. The remaining 45 percent of the lands to be retired are assumed to be included in a conservation easement and managed to improve wildlife habitat, especially near refuges.

Due to the inclusion of conservation easements for 45 percent of the land to be fallowed, and continuation of dryland farming cultivation practices for the remaining portion of the land to be fallowed, it is anticipated that the level of erosion potential will not increase under Alternative 5 as compared to the No-Action Alternative.

As discussed under Alternative 1, the increased flows probably would not increase erosion potential on the streams under Alternative 5 as compared to the No-Action Alternative.

VISUAL RESOURCES

NO-ACTION ALTERNATIVE

It is assumed that the lands to be fallowed would be reseeded with grasses and grazed by livestock or occasionally dryland farmed. These cultivation measures are similar to methods used on lands which have been historically fallowed due to crop rotation or periodic cropping pattern changes. Because the cultivated and fallowed acreage patterns are similar to historical patterns, it is anticipated that agricultural viewsheds under the No-Action Alternative would be similar to historical conditions.

Similarly, because releases from storage reservoirs are similar to historical patterns, it is anticipated that the occurrence of the so-called "bathtub ring" around the perimeter of reservoirs under the No-Action Alternative would be similar to historical conditions.

ALTERNATIVE 1

Under this alternative, irrigated acreage would be reduced by about 0.7 percent in the Central Valley. Because of the integrated use of surface water and groundwater, the fallowed land would be located contiguously. Therefore, it is anticipated that the general cultivated and fallowed acreage patterns would be similar to historical patterns, and that agricultural view sheds under Alternative 1 would be similar to the No-Action Alternative.

The operation of certain CVP reservoirs to increase end-of-month storage in September would reduce the occurrence of the "bathtub ring" effect at those lakes, particularly during the summer months when they experience substantial use.

ALTERNATIVE 2

Under this alternative, irrigated acreage would be reduced by about 1.3 percent in the Central Valley. Because of the integrated use of surface water and groundwater, the fallowed land would be located contiguously. Therefore, it is anticipated that the general cultivated and fallowed acreage patterns would be similar to historical patterns, and that agricultural view sheds under Alternative 2 would be similar to the No-Action Alternative.

The operation of certain CVP reservoirs to increase end-of-month storage in September would reduce the occurrence of the "bathtub ring" effect at those lakes, particularly during the summer months when they experience substantial use.

ALTERNATIVE 3

Under this alternative, irrigated acreage would be reduced by about 3.9 percent in the Central Valley. Because of the integrated use of surface water and groundwater, the fallowed land would be located contiguously. It is assumed that about 15 percent of the fallowed land would be managed as conservation lands, which would add to the visual resources. However, this would be less than 0.5 percent of the irrigated land under the No-Action Alternative. Therefore, it is anticipated that the general cultivated and fallowed acreage patterns would be similar to historical patterns, and that agricultural view sheds under Alternative 3 would be similar to the No-Action Alternative.

The operation of certain CVP reservoirs to increase end-of-month storage in September would reduce the occurrence of the "bathtub ring" effect at those lakes, particularly during the summer months when they experience substantial use.

ALTERNATIVE 4

Under this alternative, irrigated acreage would be reduced by about 4.8 percent in the Central Valley. Because of the integrated use of surface water and groundwater, the fallowed land would be located contiguously. It is assumed that about 15 percent of the fallowed land would be managed as conservation lands, which would add to the visual resources. However, this would be less than 0.7 percent of the irrigated land under the No-Action Alternative. Therefore, it is anticipated that the general cultivated and fallowed acreage patterns would be similar to historical patterns, and that agricultural view sheds under Alternative 4 would be similar to the No-Action Alternative.

The operation of certain CVP reservoirs to increase end-of-month storage in September would reduce the occurrence of the "bathtub ring" effect at those lakes, particularly during the summer months when they experience substantial use.

ALTERNATIVE 5

Under this alternative, irrigated acreage would be reduced by about 35.4 percent in the Central Valley. Because of the integrated use of surface water and groundwater, the fallowed land would be located contiguously. It is assumed that about 45 percent of the fallowed land would be managed as conservation lands, which would add to the visual resources. However, this would be less than 16 percent of the irrigated land under the No-Action Alternative. Therefore, it is anticipated that the general cultivated and fallowed acreage patterns would be similar to historical patterns, and that agricultural view sheds under Alternative 5 would be similar to the No-Action Alternative.

The operation of certain CVP reservoirs to increase end-of-month storage in September would reduce the occurrence of the "bathtub ring" effect at those lakes, particularly during the summer months when they experience substantial use.

DELTA AS A SOURCE OF DRINKING WATER

Impacts on drinking water quality for Delta water supplies are dependent upon changes in freshwater inflows, Delta exports, and upstream agricultural return flows during the summer and fall months.

NO-ACTION ALTERNATIVE

Under the No-Action Alternative, Delta salinity would be reduced in many months as compared to recent Delta conditions described in the Affected Environment section of the Public Health Technical Appendix. Agricultural return flows would not change significantly compared to conditions described in the Affected Environment. However, agricultural return flow quality would improve due to the recent implementation of more stringent water quality and hazardous substances requirements.

Salinity concentrations under the No-Action Alternative as compared to Affected Environment conditions discussed in the Public Health Technical Appendix are primarily influenced by the implementation of the Bay-Delta Plan Accord as compared to operations under the SWRCB Decision 1485 (D-1485). The Bay-Delta Plan Accord incorporated the municipal and industrial water supply quality standards included in D-1485. Therefore, under the No-Action Alternative, the Delta system was not operated specifically to improve drinking water quality as compared to historical operations. However, due to increased winter and spring flows from the Sacramento and San Joaquin River systems, salinity is reduced in those months.

The No-Action Alternative also reflects recent operations of New Melones Reservoir to meet the water quality provisions of D-1422 to the best extent possible for salinity concentrations in the San Joaquin River at Vernalis. The recent operations are different from historic operations in the 1980s when the New Melones Reservoir was placed into operation. The initial reservoir operations were modified to provide a portion of water to all users during worst drought in recorded history on the Stanislaus River. The operations under D-1422 and the No-Action

Alternative decrease salinity concentrations in the spring, summer, and fall months as compared to historic conditions described in the Affected Environment.

ALTERNATIVE 1

Delta inflow from the Sacramento River system is similar under Alternative 1 and the No-Action Alternative, except in July of below normal and dry years when inflows are reduced under Alternative 1 due to reduced imports from the Trinity River system. Delta exports are reduced in June through September due to operations under the (b)(2) Water Methodology. The overall impact to Delta outflow is no change under Alternative 1 as compared to the No-Action Alternative.

Salinity in the San Joaquin River upstream of the confluence with the Stanislaus River increases slightly in March under Alternative 1 as compared to the No-Action Alternative due to increased deliveries to and return flows from the San Luis Complex refuges. However, this increased salinity is reduced either by high spring runoff flows or by higher flows from the Stanislaus River that are released in March to meet instream Draft AFRP Plan target flows. Therefore, Delta salinity at Collinsville is unchanged as compared to the No-Action Alternative, except for a slight increase (about 10 to 15 percent) in July of below normal and dry water year types due to the reduced Sacramento River inflows.

Therefore, based upon the minor changes in Delta flows and salinity, Delta water quality for drinking water uses is similar in Alternative 1 as compared to the No-Action Alternative.

ALTERNATIVE 2

Delta inflow from the Sacramento River system is similar under Alternative 2 and the No-Action Alternative, except in July of below normal and dry years when inflows are reduced under Alternative 2 due to reduced imports from the Trinity River system. Delta exports are reduced in June through September due to operations under the (b)(2) Water Methodology. In addition, water acquired on the San Joaquin River under this alternative will increase or not impact flows in the Delta in most months. The overall impact to Delta outflow is no change under Alternative 2 as compared to the No-Action Alternative.

Salinity in the San Joaquin River upstream of the confluence with the Stanislaus River increases slightly in March under Alternative 2 as compared to the No-Action Alternative due to increased deliveries to and return flows from the San Luis Complex refuges. However, this increased salinity is reduced either by high spring runoff flows or by higher flows in the San Joaquin River tributaries that are acquired in the spring to meet instream Draft AFRP Plan target flows. Therefore, Delta salinity at Collinsville is unchanged as compared to the No-Action Alternative, except for a slight increase (10 to 15 percent) in July of below normal and dry water year types due to the reduced Sacramento River inflows.

Irrigated acreage upstream of the Delta is reduced by less than 2 percent under this alternative as compared to the No-Action Alternative. Most of this change is related to reductions in acreage of pasture and hay, rice, cotton, and other field crops such as sugar beets. This reduction in

irrigated acreage also reduces the return flows which could reduce concentrations of Disinfection Byproducts (DBP) precursors.

Therefore, based upon the minor changes in Delta flows and salinity, and minor reductions in irrigated acres and associated return flows, Delta water quality for drinking water uses is similar or slightly improved in Alternative 2 as compared to the No-Action Alternative.

ALTERNATIVE 3

Delta inflow from the Sacramento River system is similar under Alternative 3 and the No-Action Alternative, except in July of below normal and dry years when inflows are reduced under Alternative 3 due to reduced imports from the Trinity River system. Delta exports are reduced in June through September due to operations under the (b)(2) Water Methodology. In addition, water acquired on the San Joaquin River under this alternative will increase or not impact flows in the Delta in most months. The overall impact to Delta outflow is no change under Alternative 3 as compared to the No-Action Alternative.

Salinity in the San Joaquin River upstream of the confluence with the Stanislaus River increases slightly in March under Alternative 3 as compared to the No-Action Alternative due to increased deliveries to and return flows from the San Luis Complex refuges. However, this increased salinity is reduced either by high spring runoff flows or by higher flows in the San Joaquin River tributaries that are acquired in the spring to meet instream Draft AFRP Plan target flows. Therefore, Delta salinity at Collinsville is unchanged as compared to the No-Action Alternative, except for a slight increase (10 to 15 percent) in July in below normal and dry water year types due to the reduced Sacramento River inflows in that month.

Irrigated acreage upstream of the Delta is reduced by less than 5 percent under this alternative as compared to the No-Action Alternative. Most of this change is related to reductions in acreage of pasture and hay, rice, cotton, and other field crops such as sugar beets. This reduction in irrigated acreage also reduces the return flows which could reduce concentrations of DBP precursors.

Therefore, based upon the minor changes in Delta flows and salinity, and minor reductions in irrigated acres and associated return flows, Delta water quality for drinking water uses is similar or slightly improved in Alternative 3 as compared to the No-Action Alternative.

ALTERNATIVE 4

Delta inflow from the Sacramento River system is slightly higher under Alternative 4 as compared to the No-Action Alternative, except in July of below normal and dry years when inflows are reduced under Alternative 4 due to reduced imports from the Trinity River system. Delta exports are reduced in June through September due to operations under the (b)(2) Water Methodology. In addition, water acquired on the San Joaquin River under this alternative will increase or not impact flows in the Delta in most months. The overall impact to Delta outflow is no change under Alternative 4 as compared to the No-Action Alternative.

Salinity in the San Joaquin River upstream of the confluence with the Stanislaus River increases slightly in March under Alternative 4 as compared to the No-Action Alternative due to increased deliveries to and return flows from the San Luis Complex refuges. However, this increased salinity is reduced either by high spring runoff flows or by higher flows in the San Joaquin River tributaries that are acquired in the spring to meet instream Draft AFRP Plan target flows. Therefore, Delta salinity at Collinsville is unchanged as compared to the No-Action Alternative, except for a slight increase (5 to 10 percent) in July in below normal and dry water year types due to the reduced Sacramento River inflows in that month.

Irrigated acreage upstream of the Delta is reduced by less than 7 percent under this alternative as compared to the No-Action Alternative. Most of this change is related to reductions in acreage of pasture and hay, rice, cotton, and other field crops such as sugar beets. This reduction in irrigated acreage also reduces the return flows which could reduce concentrations of DBP precursors.

Therefore, based upon the minor changes in Delta flows and salinity, and minor reductions in irrigated acres and associated return flows, Delta water quality for drinking water uses is similar or slightly improved in Alternative 4 as compared to the No-Action Alternative.

ALTERNATIVE 5

Delta inflow from the Sacramento River system is much higher under Alternative 5 as compared to the No-Action Alternative because all surface water diversions, except 75 percent of what is currently diverted by Central Valley municipalities, are acquired. Delta exports are reduced to about 10 percent of total export pump capacity to serve Public Health and Safety uses. In addition, exports to the San Francisco Bay Area from the Tuolumne and Mokelumne rivers are acquired under Alternative 5. Therefore, Delta outflow is greatly increased in Alternative 5 as compared to the No-Action Alternative.

Salinity in the San Joaquin River is reduced (by about 90 percent) because all surface water diversions on the San Joaquin River and the tributaries are acquired under Alternative 5 as compared to the No-Action Alternative. In addition, return flows are reduced due to the reduction in irrigated acreage. Most of this change is related to reductions in acreage of pasture and hay, rice, cotton, and other field crops such as sugar beets. This reduction in irrigated acreage also reduces the return flows which would reduce concentrations of DBP precursors.

Therefore, based upon the changes in Delta flows and salinity, and reductions in irrigated acres and associated return flows, Delta water quality is improved in Alternative 5 as compared to the No-Action Alternative. However, the municipalities that use the Delta as a drinking water source under the No-Action Alternative are assumed to be willing sellers of the water supply. It is assumed they will sell the water for a price that will support the construction and operation of desalination facilities and pipelines to convey the desalinated water from the ocean to the upper pressure zones in the water service areas at no increased cost to the direct water consumers. The desalination process will remove salinity, other minerals, and most larger microorganisms. Therefore, the drinking water quality for the municipalities will be improved under Alternative 5 as compared to the No-Action Alternative due to the use of desalination.

MOSQUITOS

Factors contributing to mosquito production include (1) mosquito habitat, (2) water delivery schedule(s), (3) mosquito habitat created/displaced by changes in water allocation, and (4) pesticide use.

NO-ACTION ALTERNATIVE

Under the No-Action Alternative, surface water availability is reduced to CVP and SWP contractors as compared to historical conditions. Land use projections presented in the DWR Bulletin 160-93 indicate that some water rights holders will increase irrigated acreage. Most of the reduction in the use of surface water is projected to be replaced by groundwater. Therefore, the cropping patterns, especially for areas served by CVP water, under the No-Action Alternative will be similar to the cropping patterns described under the Affected Environment of the Public Health: Mosquitos Technical Appendix.

The No-Action Alternative includes the retirement of 45,000 acres of land identified in the SJVDP.

It is assumed that the lands to be retired or fallowed would be reseeded with grasses and grazed by livestock, or occasionally dryland farmed. These cultivation measures are similar to methods used on lands which have been historically fallowed due to crop rotation or periodic cropping pattern changes.

Because the cultivated and fallowed acreage patterns are similar to historical patterns, it is anticipated that mosquito habitat distribution under the No-Action Alternative would be similar to historical conditions.

ALTERNATIVE 1

Alternative 1 would provide firm delivery of Level 2 water supply to the refuges in accordance with the Refuge Water Supply Study and San Joaquin Basin Action Plan. Although the frequency of the delivery of the Level 2 water supplies could increase, as compared to the No-Action Alternative, the uses of this water at the refuges would be similar. Therefore, this water delivery provision would not substantially alter mosquito habitat conditions, as compared to those that would exist under the No-Action Alternative.

Alternative 1 also includes approximately 1,300 fewer acres of rice grown in the Central Valley than under the No-Action Alternative. Because this represents a less than 1 percent reduction of rice grown under Alternative 1 as compared to the No-Action Alternative, this reduction in acreage would not substantially alter mosquito habitat conditions, as compared to those that exist under the No-Action Alternative.

ALTERNATIVE 2

Alternative 2 would provide firm Level 4 water supply for the refuges in accordance with the Refuge Water Supply Study and San Joaquin Basin Action Plan. Depending on the refuge, this

increase in water from Level 2 to Level 4 would be used to irrigate upland habitat, expand the wetland habitat area, maintain flooded conditions for a longer period during the year, or increase the frequency of replacement water in existing wetland areas. In areas where this water is used to expand habitat area or to extend the duration of flooding, the mosquito habitat conditions would be increased. Therefore, additional abatement measures, consistent with existing practices, could be required.

Alternative 2 also includes approximately 5,300 fewer acres of rice grown in the Central Valley, which represents an approximately 1 percent reduction of rice grown under Alternative 2 as compared to the No-Action Alternative. This reduction in acreage would not substantially alter mosquito habitat conditions, as compared to those that exist under the No-Action Alternative. Depending on the distribution of affected lands, the mosquito habitat could be replaced. It is not known if the increase in abatement requirements resulting from refuge expansion would be offset by reduced requirements resulting from less rice acreage.

ALTERNATIVE 3

Impacts at the refuges would similar to those discussed under Alternative 2.

Alternative 3 also includes approximately 8,200 fewer acres of rice grown in the Central Valley, which represents less than an approximately 2 percent reduction of rice grown under Alternative 3 as compared to the No-Action Alternative. This reduction in acreage would not substantially alter mosquito habitat conditions, as compared to those that exist under the No-Action Alternative.
The impacts would be the same as those described for Alternative 2.

ALTERNATIVE 4

Impacts at the refuges would similar to those discussed under Alternative 3.

Alternative 4 also includes approximately 22,600 fewer acres of rice grown in the Central Valley, which represents an approximately 5 percent reduction of rice grown under Alternative 4 as compared to the No-Action Alternative. This reduction in acreage would not substantially alter mosquito habitat conditions, as compared to those that exist under the No-Action Alternative.
The impacts would be the same as those described for Alternative 2.

ALTERNATIVE 5

Impacts at the refuges would similar to those discussed under Alternative 3.

Alternative 5 also includes approximately 411,600 fewer acres of rice grown in the Central Valley, which represents an approximately 85 percent reduction of rice grown under Alternative 5 as compared to the No-Action Alternative.

This reduction in acreage would reduce distribution of mosquito habitat, as compared to that existing under the No-Action Alternative. The impacts would be the same as those described for Alternative 2.

CULTURAL RESOURCES

The following impact mechanisms have been identified as potentially affecting cultural resources: changes in hydrology, recreation, land use, implementation of terrestrial habitat restoration associated with land fallowing and retirement, and restoration associated with anadromous fisheries.

NO-ACTION ALTERNATIVE

Under the No-Action Alternative, Shasta Lake's high water level would be 1,067 feet above sea level, the low water level would be 902 feet, and annual visitor use days would be 16,070,826. The high water level at Lake Oroville would be 900 feet, the low level would be 652 feet, and annual visitor use days would be 3,814,765. The high water level at Millerton Lake would be 578 feet, the low water level would be 464 feet, and the annual number of visitors would be 992,100. For New Melones Reservoir, the high water level would be 1,086 feet, the low water level would be 841 feet, and the annual number of visitors would be 1,188,900. For San Luis Reservoir, the high water level would be 543 feet, the low water level would be 337 feet, and the annual number of visitors would be 274,900.

Annual visitor use days on the upper Sacramento River would be 26,000; on the lower Sacramento River, 195,300; on the Feather River, 103,400; and on the American River, 99,400. The annual number of visitors to the Sacramento-San Joaquin Delta under the No-Action Alternative would be 262,000.

No agricultural land would be fallowed or retired. Approximately 3,925,500 acres of orchard and 4,724,000 acres of rice would be under production in the Sacramento River Region, 33,800 acres of orchard and 2,000 acres of rice in the Sacramento-San Joaquin Delta Region, 8,012,000 acres of orchard and 13,400 acres of rice in the San Joaquin River Region, and 6,295,000 acres of orchard and 100 acres of rice in the Tulare Lake Region. No terrestrial or anadromous fisheries habitat restoration would occur, and no water above current levels would be delivered.

ALTERNATIVE 1

Under Alternative 1, high water levels at Sacramento River Region reservoirs would be the same as under the No-Action Alternative and low water levels would vary slightly from the low water levels under the No-Action Alternative. The drawdown levels may be slightly lower for San Joaquin River Region reservoirs, particularly New Melones Reservoir. Resources may be exposed more frequently than under the No-Action Alternative, and subject to more frequent wet-dry cycling and vandalism. The same potential impacts may occur along rivers in the San Joaquin River Region.

Under Alternative 1, the amount of change in annual visitor use days for reservoirs would not have an impact on cultural resources.

Under Alternative 1, approximately 1,500 acres of agricultural land would be fallowed in the Sacramento River Region, 100 acres in the Sacramento-San Joaquin Delta Region, 22,000 acres in the San Joaquin River Region, and 20,000 acres in the Tulare Lake Region. The number of

acres in orchards and in rice production would decrease compared to the No-Action Alternative. This amount of change could result in a very small benefit to cultural resources.

Under Alternative 1, refuges in this region would receive Level 2 water, resulting in the delivery of 18 percent more water than under the No-Action Alternative. Cultural resources in the areas receiving additional water could be affected by flooding or increased erosion compared to the No-Action Alternative. Impacts due to increases in vandalism resulting from increased recreational use of the refuges could also occur.

The projects currently proposed to improve anadromous fisheries habitat under Alternative 1 include considerable ground disturbance and are likely to affect cultural resources. Many of the projects are proposed to occur in areas that have a high probability of containing cultural resources. Direct impacts on cultural resources could result from the effects of constructing and operating new facilities and modifying existing facilities.

ALTERNATIVE 2

Under Alternative 2, high water levels at Sacramento River Region reservoirs would be the same as under the No-Action Alternative and low water levels would vary slightly from the low water levels under the No-Action Alternative. The drawdown levels may be slightly lower for some San Joaquin River Region reservoirs. Resources may be exposed more frequently than under the No-Action Alternative, and subject to more frequent wet-dry cycling and vandalism. The same potential impacts may occur along rivers in the San Joaquin River Region.

Under Alternative 2, approximately 6,700 acres of agricultural land would be fallowed in the Sacramento River Region, 1,700 acres in the Sacramento-San Joaquin Delta Region, 66,000 acres in the San Joaquin River Region, and 20,000 acres in the Tulare Lake Region. The number of acres in orchards and in rice production would decrease compared to the No-Action Alternative. This amount of change could result in a small benefit to cultural resources.

Under Alternative 2 refuges in this region would receive Level 4 water resulting in delivery of 40 percent more water than under the No-Action Alternative. Resources in the areas receiving additional water could be flooded or subjected to increased erosion compared to the No-Action Alternative. Impacts due to increases in vandalism resulting from increased recreational use of the refuges could also occur.

Under Alternative 2, changes due to implementation of restoration activities would be the same as those discussed under Alternative 1.

ALTERNATIVE 3

Under Alternative 3, high water levels at Sacramento River Region reservoirs would be the same as under the No-Action Alternative and low water levels would vary slightly from the low water levels under the No-Action Alternative. The drawdown levels may be slightly lower for San Joaquin River Region reservoirs, particularly New Melones Reservoir. Resources may be exposed more frequently than under the No-Action Alternative, and subject to more frequent

wet-dry cycling and vandalism. The same potential impacts may occur along rivers in the San Joaquin River Region, particularly on the San Joaquin River.

Under Alternative 3, approximately 3,900 acres of agricultural land would be fallowed in the Sacramento River Region, 1,900 acres in the Sacramento-San Joaquin River Region, 270,000 acres in the San Joaquin River Region, and 19,000 acres in the Tulare Lake Region. The number of acres in orchards and in rice production would decrease compared to the No-Action Alternative, particularly in the San Joaquin River Region. This amount of change could result in a substantial benefit to cultural resources because resources that are located on these lands would be relieved from any adverse impacts that result from ongoing agricultural practices. Benefits would also occur from the reduction of orchards and rice production because cultivating these crops has a high potential to disturb cultural resources.

Under Alternative 3, refuges in this region would receive Level 4 water resulting in delivery of 40 percent more water than under the No-Action Alternative. Resources in the areas receiving additional water could be flooded or subjected to increased erosion compared to the No-Action Alternative. Impacts due to increases in vandalism resulting from increased recreational use of the refuges could also occur.

The projects currently proposed to improve anadromous fisheries habitat under Alternative 3 include considerable ground disturbance and are likely to affect cultural resources. Many of the projects are proposed to occur in areas that have a high probability of containing cultural resources. Direct impacts on cultural resources could result from the effects of constructing and operating new facilities and modifying existing facilities.

ALTERNATIVE 4

Under Alternative 4, high water levels at Sacramento River Region reservoirs would be the same as under the No-Action Alternative and low water levels would vary slightly from the low water levels under the No-Action Alternative. The drawdown levels may be slightly lower for San Joaquin River Region reservoirs, particularly New Melones Reservoir. Resources may be exposed more frequently than under the No-Action Alternative, and subject to more frequent wet-dry cycling and vandalism. The same potential impacts may occur along rivers in the San Joaquin River Region, particularly on the San Joaquin River.

Under Alternative 4, approximately 35,000 acres of agricultural land would be fallowed in the Sacramento River Region, 3,000 acres in the Sacramento-San Joaquin River Region, 305,000 acres in the San Joaquin River Region, and 18,900 acres in the Tulare Lake Region. The number of acres in orchards and in rice production would decrease compared to the No-Action Alternative, particularly in the Sacramento River and San Joaquin River Regions. This amount of change could result in a substantial benefit to cultural resources because resources that are located on these lands would be relieved from any adverse impacts that result from ongoing agricultural practices. Benefits would also occur from the reduction of orchards and rice production because cultivating these crops has a high potential to disturb cultural resources.

Under Alternative 4, refuges in this region would receive Level 4 water resulting in delivery of 40 percent more water than under the No-Action Alternative. Resources in the areas receiving

additional water could be flooded or subjected to increased erosion compared to the No-Action Alternative. Impacts due to increases in vandalism resulting from increased recreational use of the refuges could also occur.

The projects currently proposed to improve anadromous fisheries habitat under Alternative 4 include considerable ground disturbance and are likely to affect cultural resources. Many of the projects are proposed to occur in areas that have a high probability of containing cultural resources. Direct impacts on cultural resources could result from the effects of constructing and operating new facilities and modifying existing facilities.

ALTERNATIVE 5

Under Alternative 5, high water levels at Sacramento River Region reservoirs would be the same as under the No-Action Alternative and low water levels would vary slightly from the low water levels under the No-Action Alternative. The drawdown levels would be lower for San Joaquin River Region reservoirs, particularly Millerton Lake, San Luis Reservoir, and New Melones Reservoir. Resources may be exposed more frequently than under the No-Action Alternative, and subject to more frequent wet-dry cycling and vandalism. The same potential impacts may occur along rivers in the San Joaquin River Region, particularly the San Joaquin River itself.

Under Alternative 5, approximately 729,000 acres of agricultural land would be fallowed in the Sacramento River Region. The number of acres in orchards would decrease by 8,000 acres and 399,400 fewer acres of rice would be under production compared with the No-Action Alternative. Approximately 365,000 acres of agricultural land would be fallowed in the Sacramento-San Joaquin Delta Region. Approximately 16,000 acres of orchard and 1,500 fewer acres of rice would be in production in the Delta. Approximately 995,000 acres of agricultural land would be fallowed in the San Joaquin River Region. The amount of land planted in orchards would be reduced by 137,000 acres, and rice production would be reduced by 11,000 acres. Approximately 418,000 acres of agricultural land would be fallowed in the Tulare Lake Region. Land planted in orchards would decrease by 6,900 acres and no rice would be produced. The fallowing of 2,500,000 acres could provide a substantial benefit to cultural resources because resources that are located on those lands would be relieved from any adverse impacts that would result from ongoing agricultural practices. Benefits would also occur from the reduction in orchard and rice acreages because cultivating these crops has high potential to disturb cultural resources.

Under Alternative 5, refuges in this region would receive Level 4 water resulting in delivery of 40 percent more water than under the No-Action Alternative. Resources in the areas receiving additional water could be flooded or subjected to increased erosion compared to the No-Action Alternative. Impacts due to increases in vandalism resulting from increased recreational use of the refuges could also occur.

The projects currently proposed to improve anadromous fisheries habitat under Alternative 5 include considerable ground disturbance and are likely to affect cultural resources. Many of the projects are proposed to occur in areas that have a high probability of containing cultural resources. Direct impacts on cultural resources could result from the effects of constructing and operating new facilities and modifying existing facilities.

CHAPTER IV

RESULTS OF SCREENING PROCESS

C-081218

Chapter IV

RESULTS OF SCREENING PROCESS

EVALUATION OF THE INITIAL ALTERNATIVES

The alternatives were evaluated with respect to biological, physical, and human resources to identify benefits and potential adverse impacts, as summarized in Chapter II. A major discriminator between alternatives was the implementation program for the fish management and water management packages. The results of the initial impact assessment are summarized in Table IV-1.

The results indicate that as stream flow increases through implementation of the alternatives, conditions for the fishery improve. However, to make water available for the increased stream flows, water use by agricultural and municipal users must be reduced. This reduction in water demand is made possible through conservation, changes in cropping patterns, fallowing of land, reduction in municipal development, and construction of desalination water treatment plants to treat ocean water for municipal uses. These actions are directly related to the cost of water in this analysis. Therefore, as more water is provided to increase stream flows, more stringent actions will be implemented to provide the needed water. Therefore, the cost of water in Alternatives 3, 4, and 5 will be substantially higher than the price of water in Alternatives 1 or 2.

For the purposes of this analysis, it was assumed that all parties would be willing sellers. However, on some streams, implementation of all of the actions would not provide adequate stream flow to meet the Draft AFRP Working Paper target flows. Therefore, on those streams full water amounts were not available to fully meet the objectives of Alternatives 4 and 5.

COMPARISON OF RESULTS OF INITIAL IMPACT ASSESSMENT WITH SCREENING CRITERIA

The results of the impact assessment were compared to the screening criteria. As discussed in Chapter II, the screening criteria for this analysis have focused on the Fish Management and Water Management packages of the alternatives. The summary of the comparison of the impact assessment results with the screening criteria are presented below:

- Biological Priorities. The flow objectives in Alternatives 1 and 2 were based upon the Draft AFRP Plan flow objectives which had been developed based upon a prioritization of the use of blocks in a manner that met reasonableness criteria for the CVP-controlled streams, Delta, and Tuolumne and Merced rivers.

TABLE IV-1

SUMMARY OF IMPACT ASSESSMENT OF PRELIMINARY ALTERNATIVES

COMPARISON WITH SCREENING CRITERIA	PRELIMINARY ALTERNATIVE 1	PRELIMINARY ALTERNATIVE 2	PRELIMINARY ALTERNATIVE 3	PRELIMINARY ALTERNATIVE 4	PRELIMINARY ALTERNATIVE 5
Biological Criteria: Flows must be managed in a way to support biological priorities, including species and lifestages.	Draft AFRP Restoration Plan target flows and non-flow actions. Improved conditions for chinook salmon and steelhead in Clear Creek and Sacramento, American, and Stanislaus rivers and the Delta.	Draft AFRP Restoration Plan target flows and non-flow actions. Benefits similar to those under Alternative 1. Improvements for chinook salmon in Stanislaus, Tuolumne, and Merced Rivers and for sturgeon, striped bass, and American shad in Delta.	Draft AFRP Working Paper target flows and Draft AFRP Restoration Plan non-flow actions. Benefits similar to those under Alternative 2. Additional improvements for chinook salmon in Stanislaus, Tuolumne, and Merced rivers, and for sturgeon, striped bass, and American shad in Delta.	Draft AFRP Working Paper target flows and Draft AFRP Restoration Plan non-flow actions. Benefits similar to those under Alternative 3 . Additional improvements for chinook salmon in all Delta tributaries, and for sturgeon, striped bass, and American shad in Delta.	Draft AFRP Working Paper target flows and non-flow actions. Benefits to all Delta tributaries and to the Delta due to reduced diversions and increased flows.
Water Availability: Flows must be physically available without impacting existing CVP water rights or operating requirements	Water made available through Reoperation and (b)(2) Water. Decrease in CVP deliveries by an average of 240,000 af/year. No acquired water.	Water made available through Reoperation and (b)(2) Water as in Alternative 1. Purchase up to 170,000 acre-feet on Stanislaus, Tuolumne, and Merced rivers. Water physically available for acquisition.	Water made available through Reoperation and (b)(2) Water as in Alternative 1. Purchase up to 1,280,000 acre-feet on Stanislaus, Tuolumne, and Merced rivers. Water not physically available for acquisitions in all years.	Water made available through Reoperation and (b)(2) Water as in Alternative 1. Purchase up to 1,590,000 acre-feet on Delta tributaries. Water not physically available for acquisitions in all years.	Water made available through Reoperation and (b)(2) Water as in Alternative 1. Purchase of over 12,000,000 acre-feet on Delta tributaries. Water not physically available for acquisitions in all years.
Reasonable Cost of Acquired Water: Less than $150/acre-foot	No acquired water.	Less than $100/acre-foot.	More than $150/acre-foot.	More than $150/acre-foot.	From $150 to $1,200/acre-foot.
Fund Availability for Restoration Fund Portion of total cost: less than $120 million/year.	Costs of Actions funded by "Restoration Fund Share" less than $50 million/year	Costs of Actions funded by "Restoration Fund Share" about $50 million/year	Costs of Actions funded by "Restoration Fund Share" about $300 million/year	Costs of Actions funded by "Restoration Fund Share" about $400 million/year	Costs of Actions funded by "Restoration Fund Share" about $9 billion/year
Summary	Meets Screening Criteria for water acquisition.	Meets Screening Criteria for water acquisition.	Adequate water not available in all years for acquisition. Cost and Funding do not meet Screening Criteria.	Adequate water not available in all years for acquisition. Cost and Funding do not meet Screening Criteria.	Adequate water not available in all years for acquisition. Cost and Funding do not meet Screening Criteria.

The flow objectives or targets in Alternatives 3, 4, and 5 were based upon the initial efforts of the AFRP to reflect flow objectives presented in the Draft AFRP Working Paper. These initial flow objectives had not been subjected to screening with reasonableness criteria, including the development of biological priorities. Therefore, flow objectives were evaluated in their entirety rather than in a phased implementation manner in the impact assessment of the initial alternatives. This type of analysis led to flow objectives which were difficult to evaluate biologically.

- Water Availability. Water is physically available to meet the flow objectives for Alternatives 1 and 2. However, adequate water is not available in all years on many streams to meet the flow objectives in Alternatives 3, 4, and 5.

  Water is not available in many years to meet the flow objectives on the Sacramento River in Alternatives 4 and 5 without increasing adverse impacts to winter-run chinook salmon. On the Mokelumne River and several other rivers, water was not physically available in many years due to lack of storage capacity to allow re-operation of the rivers to meet the proposed flow patterns in Alternatives 4 and 5. Finally, the total amount of water was not physically available on many rivers in many years due to natural hydrology and because the flow objectives were established for average water year types in Alternatives 3, 4, and 5.

- Cost of Water. There would be no acquired water in Alternative 1. The cost of acquired water in Alternative 2 would be less than $100 per acre-foot. The cost of acquired water in Alternatives 3, 4, and 5 would significantly exceed $150 per acre-foot, and in Alternative 5 the costs would exceed $1,200 per acre-foot to replace municipal water supplies with desalination treatment plants. The cost of water under Alternatives 3, 4, and 5 was considered to be extremely high under the screening criteria.

- Fund Availability. For this analysis it was assumed that a restoration fund amount of up to $50 million per year would be available and that additional funds would be available from matching funds associated with other federal and state programs as required by CVPIA. Therefore, it was assumed that a total funding capability of up to $120 million per year would be considered available.

  The Restoration Fund-type costs for Alternatives 1 and 2 are $33 million per year and $50 million per year, respectively. The Restoration Fund-type costs for Alternatives 3, 4, and 5 are $300 million per year, $400 million per year, and $9 billion per year. The funding requirements for Alternatives 3, 4, and 5 were considered high under the screening criteria.

SUMMARY OF THE SCREENING PROCESS

Based upon the screening process, it appears that Alternatives 1 and 2 would meet the screening criteria associated with biological priorities, water availability, cost of water, and fund availability.

Alternatives 3, 4, and 5 were considered to improve fishery conditions, although the flow objectives used in these alternatives did not attempt to prioritize blocks of water within the stream. Therefore, it would be difficult to phase implementation of these alternatives.

Alternatives 4 and 5 did not have adequate water available in all water years to meet the flow objectives.

Alternatives 3, 4, and 5 would have extremely high water costs and require extensive funds in excess of the Restoration Fund.

Based upon this analysis, Alternatives 3, 4, and 5 were screened from further detailed evaluation.

DEVELOPMENT OF REVISED ALTERNATIVES

Subsequent to the initial impact assessment, the AFRP evaluated how blocks of water can be used on each stream to improve conditions. The uses of the blocks of water were prioritized to improve fishery conditions based upon current scientific knowledge and interactions of various lifestages and interaction between streams. The prioritized actions were developed for the Yuba, Feather, Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced rivers and for the Delta. In addition, actions for the Sacramento and American rivers were slightly revised subsequent to the Draft AFRP Plan. This information would be used to develop NEW Alternatives 3 and 4 based upon the four screening criteria used in this report. The new alternatives with Alternatives 1 and 2 would provide an appropriate range of implementation actions to allow the decision makers and interested parties to evaluate various methods to implement the Fish Management and Water Management packages. To provide the appropriate range of methodologies, the following alternatives will be considered in the Draft PEIS.

- Alternative 1. As described in Chapter II.

- Alternative 2. As described in Chapter II.

- Alternative 3. All actions except the Fish and Water Management packages would be the same as Alternative 2. The flow objectives would be developed using the prioritized actions developed by the AFRP in October 1996 and the four screening criteria used in this report. This alternative also would use (b)(2) Water only on the CVP-controlled streams and not in the Delta, as in Alternative 1. Acquired water would be allowed to be exported if all other Delta water quality and flow objectives were met.

- Alternative 4. All actions except Fish Management and Water Management packages would be the same as Alternative 2. The flow objectives would be developed using the prioritized actions developed by the AFRP in October 1996 and the four screening criteria used in this report. This alternative also would use (b)(2) water on the CVP-controlled streams and in the Delta, as in Supplemental Analysis 1a. Acquired water would not be allowed to be exported, and would be used to increase Delta outflow, as in Alternative 2.